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WEGMANN'S PORCELAIN CYLINDER MILL.

We illustrate in the accompanying plate a type of mill with two porcelain cylinders invented by Mr. Wegmann, of Oerlikon, Switzerland.

This apparatus is especially distinguished by an arrangement which, acting automatically, withdraws the pressure from the cylinders as soon as the feed-hopper is on the point of becoming empty, and at the same time arrests the motion of the feed rollers. The object of this useful improvement is to reduce to a minimum the surveillance that such an apparatus usually requires.

Fig. 1 gives a general section of the mill perpendicular to the axis of the cylinders. Fig. 2 shows a transverse section on a line with the axis of the feed cylinder. Fig. 3 gives an external elevation of the front side, and Fig. 4 a partial horizontal projection designed to show the gearing mechanism of the principal shaft. The following Figs. 5 to 14 relate to the principal details, especially to the mechanism which effects the automatic unlocking of the working cylinders. The mill is mounted upon two cast iron frames, A, connected by cross braces, *a*, and carrying four axle boxes, B and C, in which revolve the journals of the two cylinders. The shaft, D, which receives the first cylinder, E, is the one that carries the belt pulley, F, and which is started in motion through the play of a friction gearing. The second cylinder, E, is mounted upon the shaft, G, which is driven by the other through the intermedium of two gearing wheels, H.

The material to be submitted to the action of the two cylinders is thrown into a wooden hopper, I, which is held between two cast iron supports, I^1. Upon these same supports are mounted the journals, J and J^1, of the feed rollers, K and K^1, the first of which is of fluted cast iron, and the other of smooth porcelain. One of the journals of the iron roller, K, carries at its extremity a pulley, J^2, which receives its motion from the main shaft, D, through the intermedium of a belt, J^3. The other carries a wheel, *b*, toothed internally, which engages with a pinion, b^1, affixed to the journal of the porcelain roller, which is thus driven by the former.

The axle boxes, B and C, that correspond to the shafts of the two cylinders, E and E^1, have a different arrangement, which may be studied in Figs. 7, 8, 9, and 10. The boxes, B, of the driving shaft are stationary, while the two boxes, C, of the shaft of the cylinder, E, are arranged so as to yield to the mechanism which separates the cylinders from one another. It is also through the cylinder, E^1, that the amount of pressure is regulated. The axle, G, and its boxes, C, are capable of moving vertically, although very slightly, so as to regulate the level of the two cylinders. In order that they may perform this double duty, the axle boxes, C, instead of being fixed directly upon the frames, A, are each affixed to a piece, C^1, forming a sort of rocking lever which is inserted at its lower part into an aperture formed for it in the frame, A, and is there traversed by a pin, *c*, around which it may oscillate. It may be seen from the vertical section of this part of the mechanism in Fig. 9, and from the horizontal section in Fig. 10, that this pin is made eccentric in such a way that when it is made to revolve the position is modified of the center of the part that traverses the lever, C^1, the height of which, being thus variable, permits of regulating the level of the cylinder. The passing of the pin through the lever, C^1, is effected through a rectangular opening which permits of its introduction laterally, and which is afterward closed by a plate, *d*, that is fastened by a bolt, *e*, belonging to the key, e^1. This latter through the intermedium of a spring, *f*, presses a piece, *f*, against the pin, *c*, in such a way as to secure the stability of this point of oscillation with respect to the lever, C^1.

The object of causing this lever, C^1, and the mechanism of the cylinder to oscillate is to effect the displacement required by the elastic locking of the cylinder, E^1, against the fixed cylinder, E. The mechanism that permits of effecting the latter operation is devised for that purpose primarily, and secondarily for the automatic unlocking of which we have spoken. In order to describe these two functions as clearly as possible, we will speak of them separately, and occupy ourselves first with the locking.

Fig. 7, which represents one of the two sides of the machine, shows that the upper arm of the lever, C^1, is connected with a frame containing springs, which, in Fig. 8, are shown in horizontal projection.

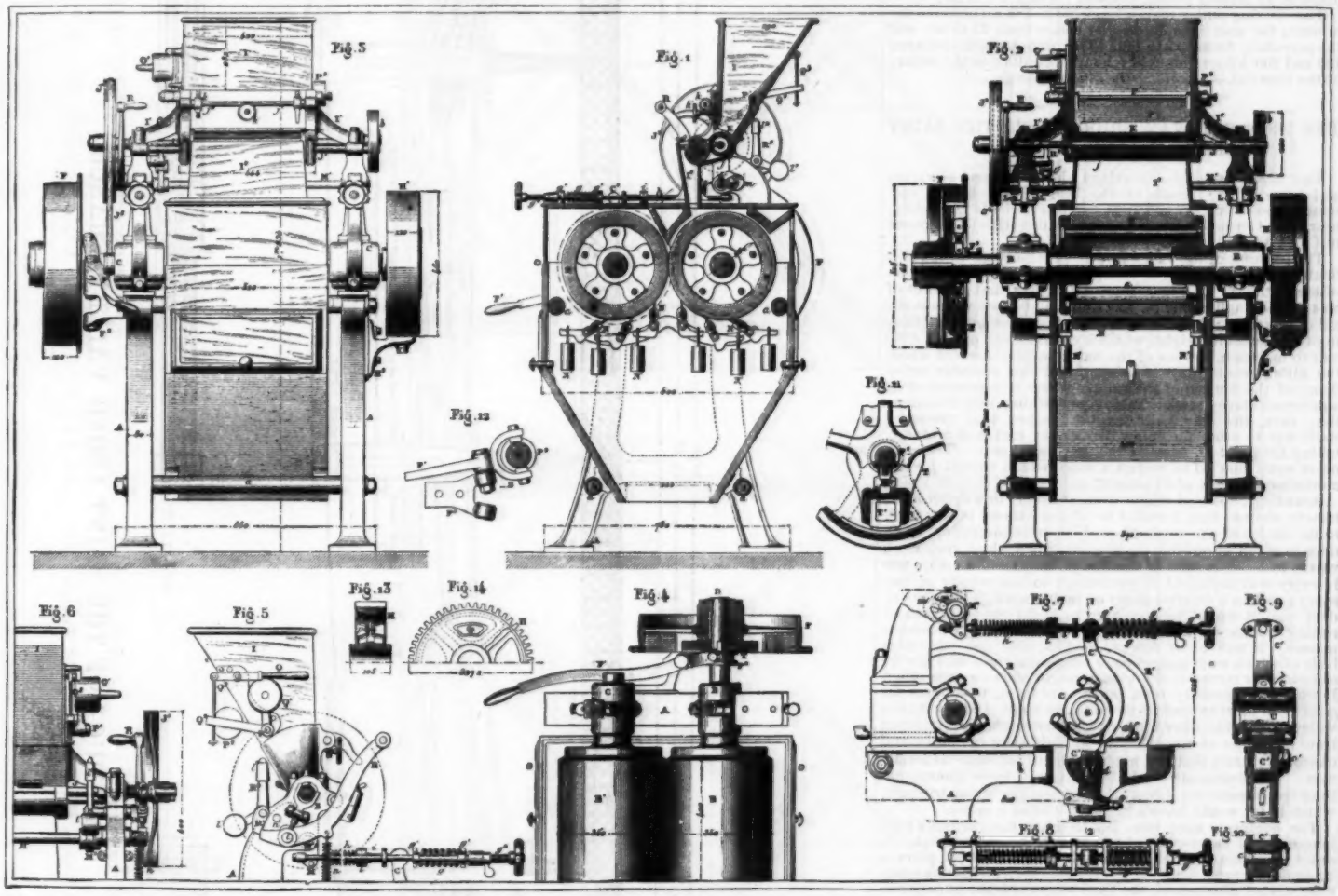
This frame, which is duplicated on the other side of the mill, consists of two horizontal rods, L, united at their extremities by cross-pieces, L^1 and L^2. The part in front of this frame is provided with a powerful spring, *g*, held between two pieces, *g*, and submitted to the action of a screw, *g*, designed to regulate the pressure required. The other part of the frame is provided with a spring, *h*, which bears at one end against the piece, h^1, and at the other against the flange, *i*, and of a hollow cylinder, *i*, that traverses the screw itself.

When operating normally, things are arranged thus:

The two frames, L, are bolted to two small levers, M, attached to a transverse shaft, M^1, and in such a way that we may consider for the moment these two points, M, as being absolutely fixed. But, as may be seen, the arms of the lever, C^1, are held between the shoulder, *g*, of the principal spring and the rod, *i*, submitted to the action of the counter spring, *h*. So, the two frames, L, being considered as absolutely fixed and immovable pieces, the pressure of the cylinders against each other is produced by the principal springs, *g*, whose tension is regulated at will by means of the binding screws, g^2.

The hand lever, F, by means of which the starting gear is maneuvered, is shown in detail in Fig. 12. As may be seen, it pivots on a support, F^2, which is bolted to the side of the frame. The cylinders and their mechanism are very carefully inclosed in a casing, O, the lower part of which forms a hopper through which the material reaches the cylinders. To the casing is attached a spout, I^3, through which the material distributed by the feed cylinders enters the mill.

The two gear wheels, H, are likewise inclosed within a cast iron jacket, H^3, affixed to the frame through the intermedium of two supports, H^2.



WEGMANN'S PORCELAIN-CYLINDER MILL.

The porcelain feed roller, K^1, revolves much faster than the iron one, K, and is designed to spread the material uniformly throughout its length in a thin and regular layer. The bottom of the hopper, I (Fig. 1), is provided with a hinged trap, P, which, while the mill is running, lies against the side of the hopper. This trap, which is controlled by a counterpoised axle, P^1, is brought to the position shown by the dotted lines when the hopper is on the point of becoming empty, and this motion brings about the unlocking of the cylinders. This same motion of the trap effects the ungearing of the pulley, J^3, and consequently stops the feed rollers.

The important mechanism devised by Mr. Wegmann for locking the cylinders may be studied in Figs. 5, 6, 7, and 8. Examining Figs. 5 and 6, it may be seen that at the side of the hopper there is a hand lever, Q, which holds in position a counterpoise, Q^1, mounted freely upon the extremity of the axle, P, with which it has otherwise no relation. It will be seen also that this axle is provided at one of its extremities with a counterpoise lever, P^2 (Figs. 2 and 5), which tends constantly to carry the trap back to the position shown by the dotted lines in Fig. 1, and that the other extremity of the same axle carries a lever, Q^2, which is arranged for moving at the proper time a rod suspended from the hand lever, Q.

On examining the lower part of Fig. 5, there will be seen a large hand lever, R, centered at *l*, which is held by a click, R^1, whose rotary axis is provided with a bent lever, R^2, one of the branches of which is loaded with a counterpoise, *l*, while the other is simply provided with a strengthening piece, l^2, for supporting a shock. The axle end, *l*, of the lever, R, carries inside of the frame a small disk, *m* (Figs. 1 and 7), whose button, m^1, is placed between the forks of a piece, M^2, which is dependent upon the axle, M^1, that carries the spring connection, M.

These different pieces operate as follows:

As soon as the weight of the material in the hopper is sufficient to keep the trap in the position indicated, its axle, P, effects an oscillation under the influence of the counterpoise, P^3, and, as a result of this, the branch, Q^3 (Fig. 5), acting upon the tappet at the lower part of the rod, Q^4, raises the hand lever, Q, and this latter frees the counterpoise lever, Q^1. The latter, on being set free, moves to the left and locks the lever, R^2, at P, and the click, R^1, frees the lever, R. As soon as this latter is rendered free to move, it is drawn by the spiral spring, s, and allows the springs, g, to expand, and to thus annul the locking of the cylinders by causing the oscillation, through the levers, M^2, of the axle M^1, which up to this time has remained fixed—this motion being transmitted by the fork, M^x, and the winch, m, to the lever, R.

The same oscillatory motion of the lever, R, has the effect of stopping the feed rollers by throwing the pulley, J^2, out of gear. For this purpose, this lever carries a sort of helicoidal cam, n^1 (Fig. 5), with which is connected the end of the forked lever, S, that controls the gearing sleeve of the pulley.

The result obtained by this ingenious system is that the cylinders are prevented from running to no purpose under pressure.

Mr. Wegmann has succeeded in completely suppressing in these mills the noise usually produced by the gear wheels by filling their hollow interior with lead shot. This, he says, entirely stops the vibrations due to the contact of the teeth, and thus deadens the sound.

The principal dimensions of the apparatus are as follows:

Diameter of the cylinders, 0·350 m.; length, 0·400 m.; diameter of driving pulley, 0·525 m.; width, 0·110 m.;

The driving pulley makes from 160 to 180 revolutions per minute; the cast iron feed roller makes from 25 to 30; and the porcelain, from 155 to 170. The product varies between 120 and 200 kilogrammes per hour, according to the nature of the material.—*Machines, Outils et Appareils.*

THE IRON RAILWAY BRIDGE OVER THE SAINT LEGER VALLEY, FRANCE.

The accompanying engravings show a general elevation and some of the details of the iron railway bridge, constructed between 1877 and 1880, over the Saint Leger Valley, near Saint Germain en Laye, under the direction of Engineer in Chief Arnaud.

The crossing of the valley at this point, owing to the difficulties of constructing foundations, engaged the attention of the engineers for a long time. The plan first thought of was to shift and elongate the route, and cross without the aid of a viaduct; but this would have necessitated a filling in of 15 meters in height, which it would have proved difficult to maintain, in view of the nature of the marls of which the filling would have consisted, and the probable subsidence of the bottom of the valley, which is composed of an aquiferous clayey sand. Taking everything into consideration, then, the only really feasible project that presented itself was to cross the valley directly by means of a bridge, taking for point of passage the narrowest part. The engineers were thus led to project a work which should possess a maximum height of 27 meters.

Soundings, some of which were extended to a depth of 30 meters, showed that it would be of the utmost importance, in the choice of the work adopted, to cross the valley, to reduce as much as possible the supports upon which such work was to rest. A system of straight girder metallic bridge was in every way indicated in preference to one wholly of masonry; and, in a detailed study of such a work, it became evident that it would be necessary to avoid the selection of resting points upon the sloping parts of the calcareous masses. It was to be feared, in fact, that the successive beds of which such masses were composed, and which were separated by layers of moist marl, might slide on each other. It would be necessary, then, on the one hand, to support the girders on piers extending down to the chalk underlying the valley, and on the other hand, an abutment sufficiently distant from the center of the valley to be built upon the horizontal calcareous strata that had not been disturbed since its formation. The abutments would have to be of large dimensions in order to resist the thrust of the metallic superstructure, which latter would have a grade of 0·01 of a meter.

The engineers were thus led to give the viaduct a total length of 311 meters, 258 of which were to be of metal. In order to reduce as much as possible the number of piers to be sunk to a great depth, without, however, giving the spans exaggerated dimensions, the total length of the superstructure was divided up into four spans, thus limiting the number of piers to three.

A study of the metallic superstructure, moreover, led to giving the upper part of the piers, above the cap, a width of 2·18 meters and a length of 7·58, and to giving each of their faces a batter of $\frac{1}{20}$, thus making their bases on reaching the chalk 6·74 meters wide and 12·14 meters long.

It remained to decide how to sink the foundations of the piers to depths varying between 27 and 32 meters. A thorough examination of the geological structure of the locality by soundings showed that a system of foundation building in wells or in pits lined with sheeting was not practicable, and left no other alternative than that of building upon piles or upon a caisson sunk with or without compressed air. The first mode, which was the object of a summary study, seemed to promise a saving of 180,000 francs in the work generally; but, as various difficulties presented themselves, it was abandoned, and recourse was had to the method which employs compressed air, this agent to be used as little as possible, and free air to be employed as much as practicable, along with powerful means of exhaustion. With this mixed system, the masonry forming the foundation of each pier would be sunk to the chalk by means of a boiler plate caisson, forming a working chamber, and upon which the masonry would be built up in measure as the excavation deepened. The conferences held with various contractors who make a specialty of this kind of work showed that the foundations of the three piers could be constructed at the price of 80 francs per cubic meter. Under these circumstances, this system did not seem to cost much more than any of the others studied, and, as it appeared to be more expeditious, it was finally adopted.

DESCRIPTION OF THE WORK.

The Abutments.—Each of these consists of a main arched part, with a projection in front designed to support the extremities of the superstructure. The abutment on the Versailles side contains two arches, and the one on the Poissy side only one, the opening in each being 8 meters in width. The width of the abutments at the level of the roadway is 8·2 meters, and the arches are 0·7 of a meter from keystone to coping. The batter of the arch butments below the springers is $\frac{1}{10}$, and above that level the tympans are regulated to $\frac{1}{20}$. That portion of the abutments which faces the bank contains two hollow spaces, 2·10 meters in height and from 5·25 to 5·55 meters in length, capped with a semicircular arch. The central part of the abutments separating the support of the superstructure from the arches is 3·8 meters in length and 9·46 meters in width at the springers, and, like the portion just mentioned, contains hollow spaces, the design in both cases being to diminish the cubage of the masonry.

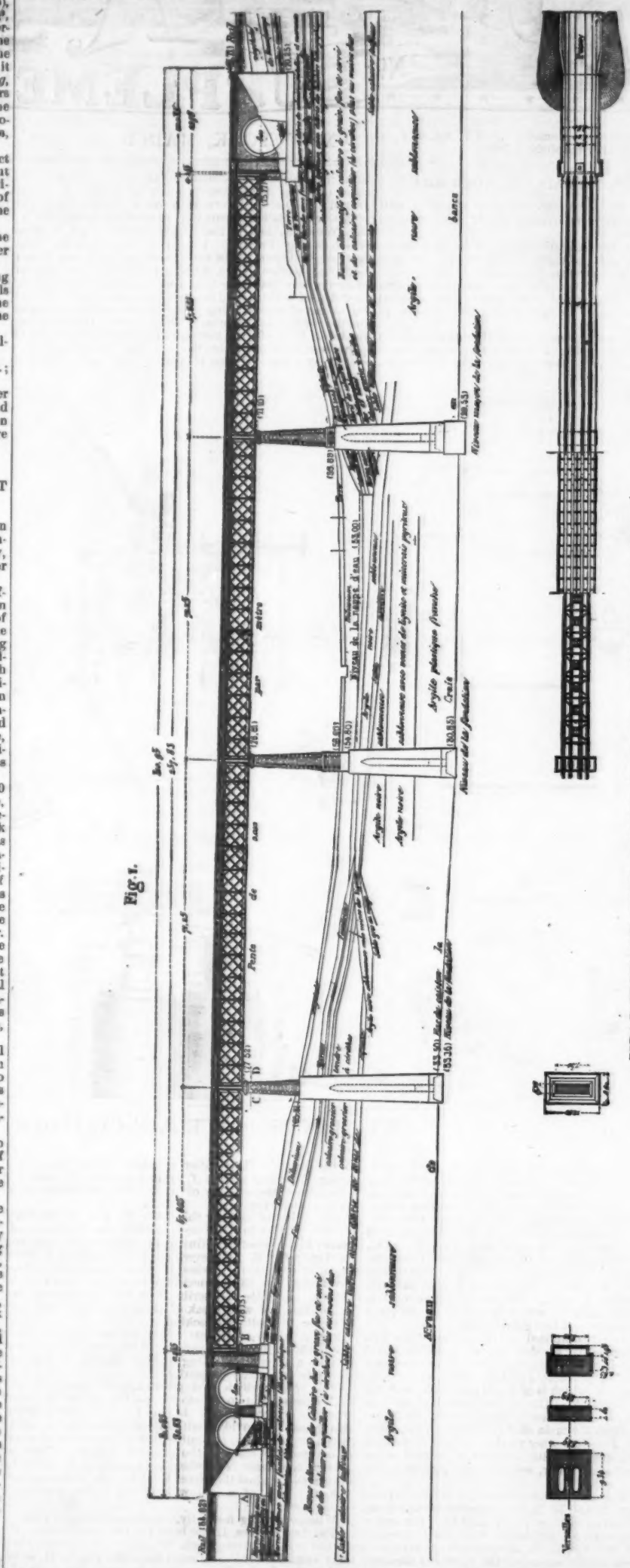


Fig. 1.

VIADUCT OF THE SAINT LEGER VALLEY, FRANCE.

The Piers.—The piers are profiled above ground with batters of $\frac{1}{20}$. Their heights, starting from the ground, are respectively 19·21, 20·21 and 17·21 meters, while those of the masonry foundations are 32·15, 25·75, and 29·36 meters. The

total heights, then, are 44·36, 45·96, and 46·57 meters, the greater part of which is hidden, as may be easily seen from these figures. Piers Nos. 2 and 3, which are the highest, are supported on pedestals having vertical faces.

Mining Arrangements.—The art of war demanded provisions to be made in the two highest piers for blowing the structure up in case of an emergency; but, as it was impossible to have chambers of the ordinary type, in so narrow columns, a new device was adopted. This consisted in forming in each pier to be destroyed two tubular well holes, 0·3 of a meter in diameter, and 10 meters in depth, lined with a smooth layer of cement and closed above by a cast iron cover. In case of war these wells are designed to receive cylinders made of plate iron and filled with 40 kilogrammes of powder, which would be fired by electricity.

The Superstructure.—The total length of the superstructure is 238·03 meters, divided up as follows: 2 end spans of 56 meters each; 2 center spans of 70 meters each; length of bearing surfaces on abutments, each 1·04 meters; and length of bearing surface on piers, 1·25 meters. The lengths of the bearing surfaces on the masonry were determined by the dimensions given by calculation, for the expansion rollers. The proportion of the central and side spans is 1·25, this being that which is best calculated to meet the resistance of the superstructure. With a view to diminishing the load on the piers as much as possible, the lightest sort of a type was adopted for the superstructure, which therefore was formed of four large lattice girders carrying the rails on top, and an external foot walk supported by brackets.

The axes of these girders correspond exactly with those of the rails of the double track. The two girders toward the bank are spaced 5·08 meters from axis to axis, and the two central ones 2·06 meters. Care was taken to construct them after the same pattern, and from the same kinds of iron selected from the types found in commerce, thus enormously simplifying the work of the builder and greatly reducing the cost price. Each girder is 5·6 meters in height, or $\frac{1}{12}$ the length of the side spans. The bottom chords are connected by angle irons of $\frac{125 \times 125}{12·5}$ to two plate iron webs 0·64 of a meter in width, and 0·015 in thickness, to which are also affixed the bars of the lattice work (Figs. 1 and 2). These latter are inclined at an angle of 45° and are formed of U iron whose width varies between 0·25 and 0·30 of a meter.

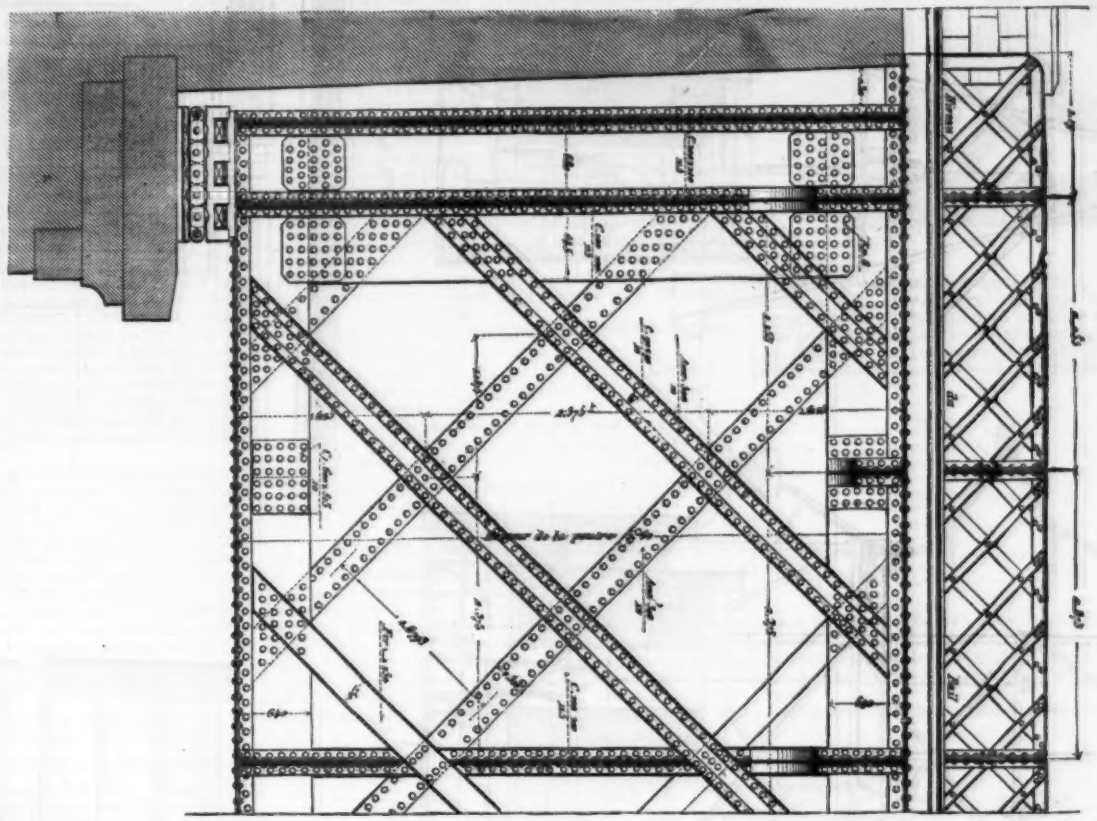


FIG. 1.

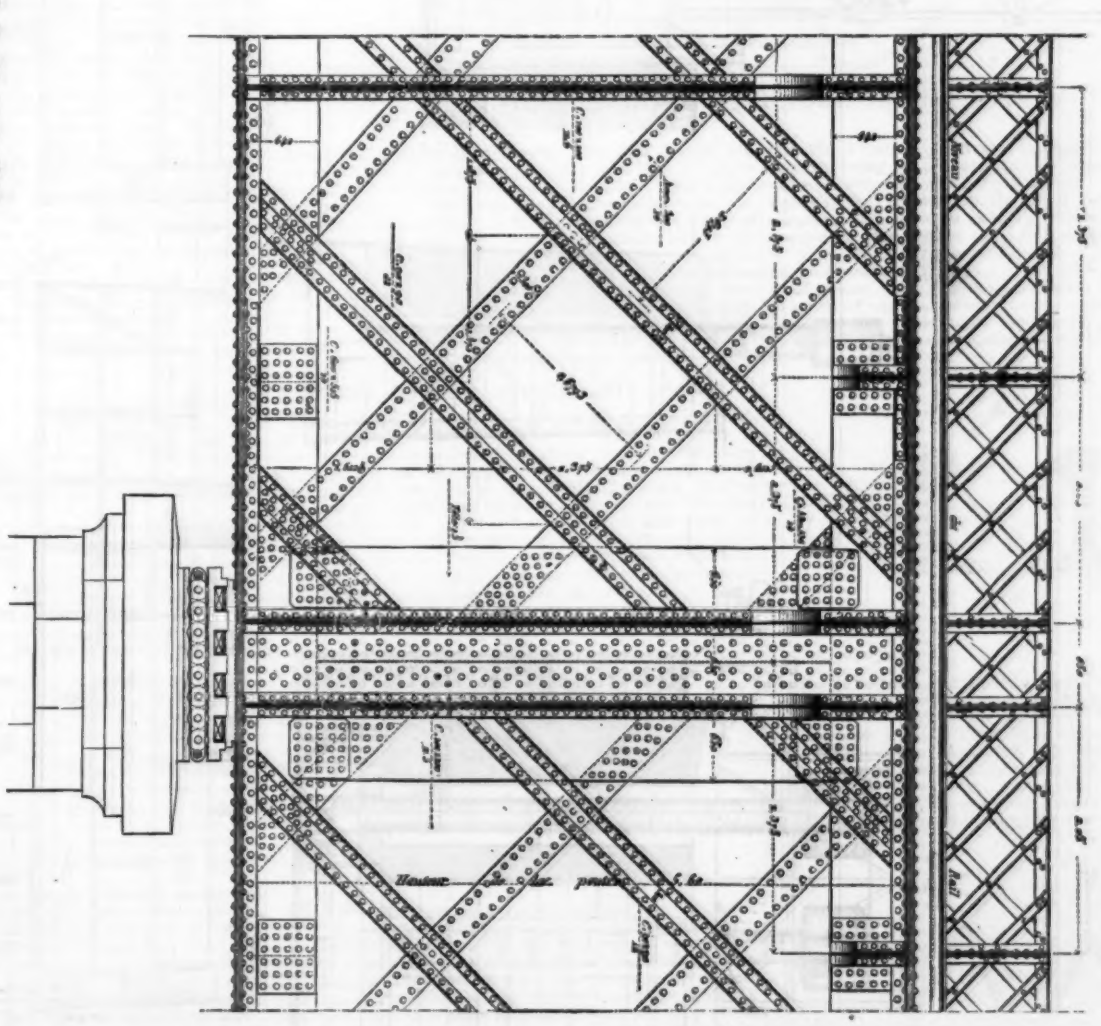


FIG. 2.

FIG. 1.—ELEVATION OF GIRDER EXTERNAL TO THE PERPENDICULAR OF AN ABUTMENT. FIG. 2.—ELEVATION OF GIRDER EXTERNAL TO THE PERPENDICULAR OF A PIER.

VIADUCT OF THE SAINT LEGER VALLEY.—DETAILS OF THE SUPERSTRUCTURE.

The chords of the large girders are formed of from 1 to 5 lengths of boiler plate of 0·01 meter in thickness.

Vertical uprights, spaced 4·75 meters from center to center, concur with the lattice work to bind together the top and bottom chords of each girder. These uprights are formed of angle irons of $\frac{100 \times 100}{11·5}$ united in pairs. The branches of these, which are perpendicular to the plane of the web of the girders, are spaced uniformly 0·008 of a millimeter, so as to take between them the angle braces that serve to attach either

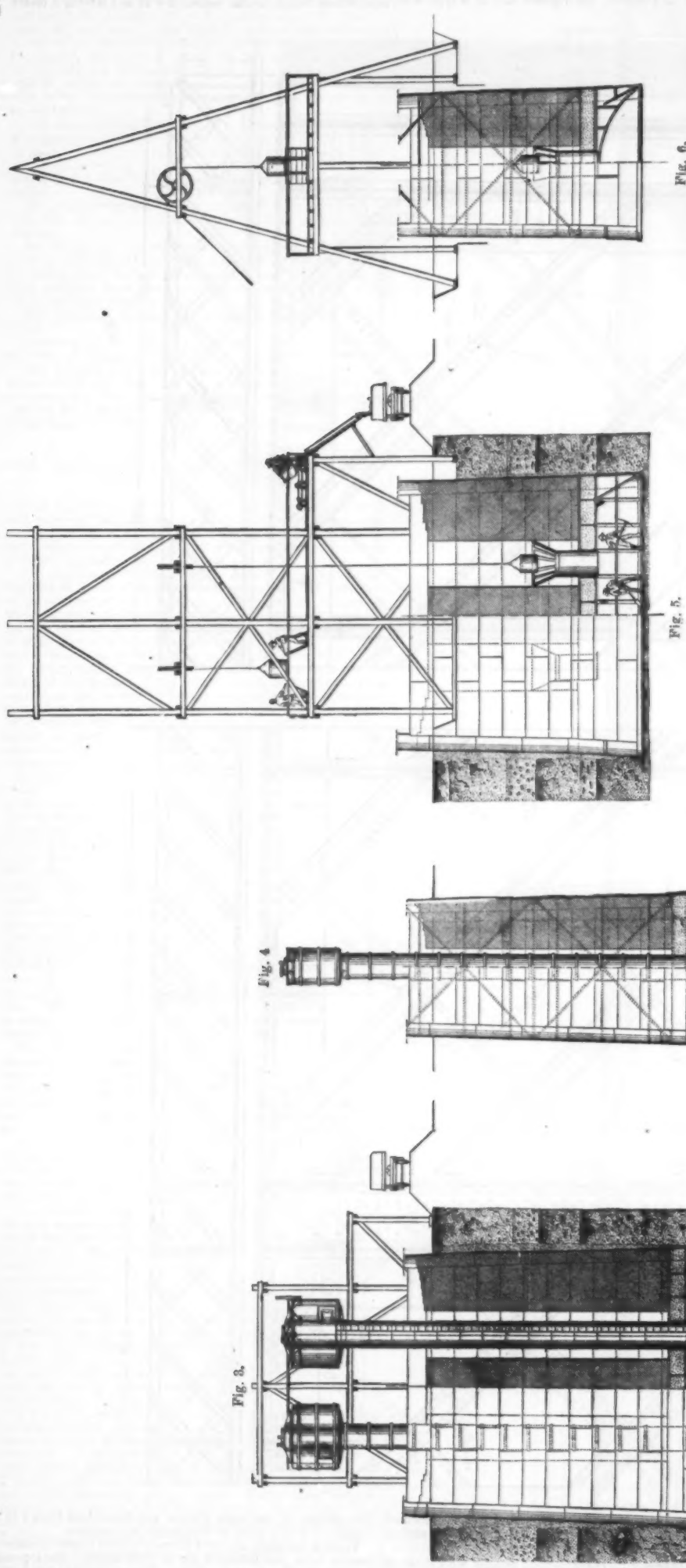


Fig. 6.

Fig. 5.

Fig. 4.

Fig. 3.

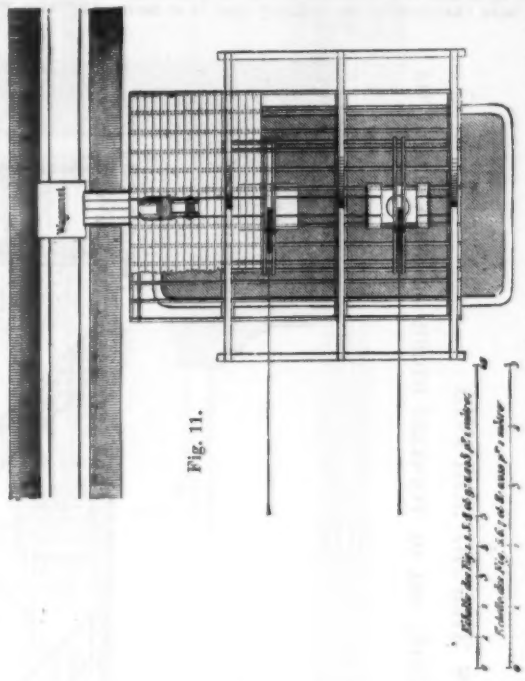


Fig. 11.

Fig. 10.

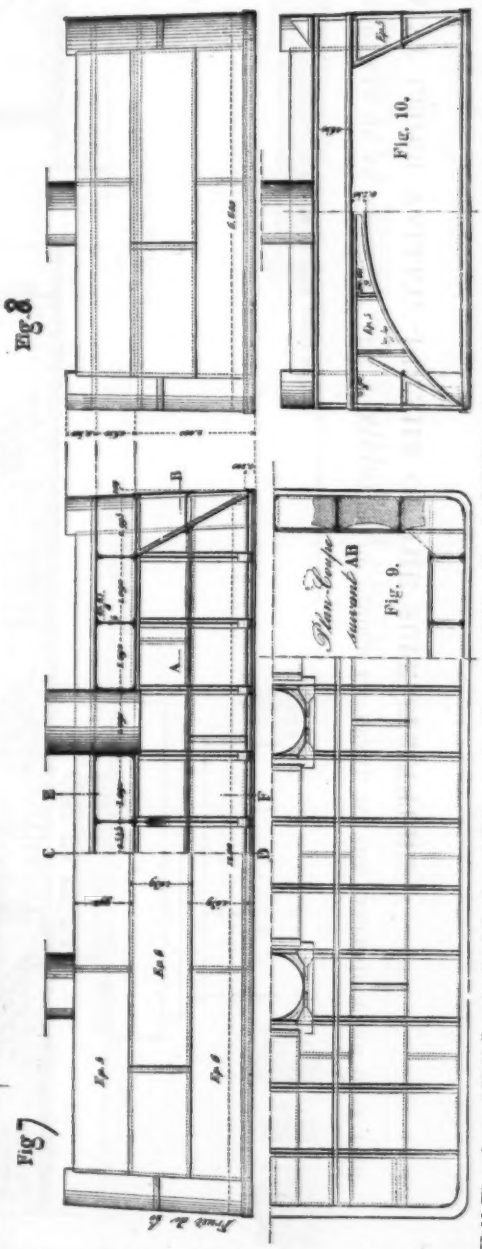


Fig. 9.

Fig. 8

Fig. 7

Fig. 8—Half Elevation and Half Longitudinal Section of Caisson using Compressed Air. Fig. 4—Half Elevation and Half Transverse Section of the Same. Fig. 5—Half Elevation and Half Longitudinal Section of Caisson open to the Air. Fig. 6—Half Elevation and Half Transverse Section of the same. Fig. 7—Half Elevation and Half Longitudinal Section. Fig. 8—Lateral Elevation. Fig. 9—Upper Plan of Caisson. Fig. 10—Section through C D, E F. Fig. 11—Upper Plan.

VIADUCT OF THE SAINT LEGER VALLEY.

flat bar which joins the two planes of the vertical bars that serve to attach the bars of the lattice work. All the pieces composing the same upright are connected by rivets. On all the bearing points the web of each girder is strengthened so as to resist crushing.

The cross girders consist of two coupled angle irons of $\frac{100 \times 100}{11.5}$, connecting the four girders at their upper and lower parts. As the upper cross girders have to carry the iron plate flooring of the superstructure, they are arranged at a distance of 2·375 meters apart. The lower cross girders exist, on the contrary, only to the right of each upright from the webs of the large girders, and are hence spaced 4·75 meters apart. Between each two uprights, that is to say at every 2·375 meters, there is laid an angle iron of $\frac{100 \times 100}{11.5}$, designed to support at the center the planks of a foot bridge running in the middle of the superstructure throughout its entire length.

The floor girders are, in addition, connected with each other in a vertical direction by a cross bracing consisting of six St. Andrew's crosses formed of U irons of $\frac{140 \times 52}{8 \times 9.75}$, and of two horizontal U irons of the same size coupled together and running through the center of the crosses. All these

the St. Andrew's crosses which form in a tranverse direction the vertical staying of the superstructure, or the foot walk brackets. As for the branches of the same angle irons, which are parallel with the plane of the webs, these are spaced 0·015 of a meter, so as to take between them a vertical

irons are attached to angle braces. At the lower part, the cross bracing of the four girders, in a horizontal direction, is secured by St. Andrew's crosses running the whole width of the superstructure. The irons composing these are of the same kind and size as those just mentioned.

The foot walks are 1·5 meters in width from the center of the guard rail to the center of the road rail, making the width of the superstructure 8·08 meters.

The Flooring.—The flooring of the superstructure is entirely of metal, and is formed of striated plate iron riveted at the four sides to the cross girders and upper chords. It weighs about 50 kilogrammes to the square meter, and is more costly than a wooden flooring, but has the advantages that it constitutes a superior horizontal bracing, and that it is durable and fireproof. The iron plates rest directly upon the cross girders, and are affixed to the upper chords, which vary in thickness, and are not in the same plane throughout the extent of the superstructure, by a flange projecting from the bottom of the chord.

The rails are affixed by screws to oak stringers 0·30 of a meter in width.

To provide for expansion, there are arranged on the abutment toward Versailles, and on each of the three piers, four roller apparatus for supporting the superstructure.

On the abutment, each apparatus contains five rollers, 0·15 m. in diameter and 0·8 m. in length, resting upon a cast iron table. On the piers, each apparatus contains eight rollers, 0·15 m. in diameter and 0·92 in length. The superstructure, having an incline of 0·010 m. per meter, in the direction from Versailles to Poissy, its lower extremity is fixed. Consequently, expansion rollers are used only on the Versailles abutment, and are dispensed with on the one toward Poissy.

The total weight of the superstructure, including the iron flooring, is: Wrought iron, 1,335 787 kilogrammes; cast iron, 52,269 kilogrammes; lead, 1,705 kilogrammes; or 5,413 kilogrammes per running meter.

Construction of the Foundations.—The caissons employed for the foundation of the piers were identical. In shape they were rectangular, with rounded corners. At the lower part, that is to say, at the level of the cutting edge, each one was 12 meters in length by 6·6 meters in width. At the upper part, that is, under the roof, these dimensions were reduced to 11·8 meters in length by 6·4 meters in width. The vertical sides had a batter in all directions of $\frac{1}{20}$. The height from the lower edges to the bottom of the roof was 2 meters. The thickness of the roof was 0·65 of a meter, and consequently the vertical distance between the lower edges and the first course of masonry was 2·65 meters. The plate iron lining of the interior of the caisson was 0·006 m. in thickness.

To prevent the sides of the caisson from giving way to lateral pressure, the edge was stiffened by an angle iron of $\frac{100 \times 100}{12}$, and the sides were provided with twenty-six vertical braces having a mean projection of 0·45 m. Finally the two larger faces of the caisson were cross-braced transversely by means of two iron plate arches and angle iron extrados. These arches were placed between the two air shafts, to the right and left of the transverse axis, and were separated by a distance of 1·95 meters. The roof consisted of ten iron girders, 6·4 meters in length, eight of which, at their two extremities, bore against the vertical braces, and the other two rested upon the two large arches which cross-braced the caisson. The dimensions of these girders were calculated in such a way that they might, while sinking, support the entire load of masonry that was to surmount them. To their lower chord there was riveted a large horizontal plate of boiler iron, 6·4 meters in width, 11·8 meters in length, and 0·006 of a meter in thickness, which formed the ceiling of the work chamber, and which was affixed to the sides of the latter by angle irons. The space between the girders was filled in with beton, so as to give perfect rigidity the whole. It was upon this layer of beton that the masonry was built up. (Figs. 7, 8, 9, and 10.)

The roof just described contained two apertures, 1·05 m. diameter, forming the base of the shafts through which the work chamber was reached. These apertures were lined with a plate iron cylinder to which was adapted the continuous iron cylinder that was to run to the air lock in case it became necessary to employ compressed air to effect the sinking of the caisson.

In subsequent operations it was found that compressed air might be dispensed with for pier No. 2, the buckets employed for excavation being found to suffice for the removal of the water contained in the clayey sand. The extraction of the material at this pier was effected by means of two buckets having a diameter of 0·75 m. and a capacity of about 0·33 of a cubic meter.

In order to maneuver these buckets there was erected over the cassion a scaffolding (Figs. 5 and 6), whose uprights rested on terra firma through the intermedium of large plates and wooden wedges, which allowed it to be raised whenever the sinking of the caisson brought about a subsidence of the earth. To this scaffolding were affixed two large channeled pulleys, over which passed cables running to a drum 0·92 m. in diameter, actuated by an 8 H. P. steam motor.

At the extremity of each cable there was attached a bucket, in such a way that while one was descending one shaft the other was rising in the second. The full bucket, when drawn up, was emptied on to a flooring affixed to the scaffolding, and the material was afterward shoveled into cars, which were drawn by a cable to the dumping ground. Afterward as the excavated material began to contain more water, it was found necessary to lay tracks on the flooring, and to place thereon a small car, by means of which the bucket was carried to the edge of the flooring and its contents dumped through a chute into the car running on the surface of the ground below (Fig. 5).

For piers No. 1 and 2 it was found necessary to employ compressed air. The air locks used were of the ordinary type (Figs. 3 and 4). They consisted of a central cylindrical chamber in constant and direct communication with the caisson, through the boiler-plate shaft, and always filled compressed air. The upper part of this chamber was traversed by a horizontal shaft running through stuffing-boxes and carrying externally a channeled pulley which was actuated, through the intermedium of a cable, by the motor that had before served to raise and lower the buckets. This same shaft carried in the interior of the air chamber a drum around which passed an endless belt that ran over a cylinder placed parallel with and directly above the axis of the shaft. It was around this drum that wound the rope that carried the buckets designed for removing the excavated material. A tightener maneuvered by a workman who remained constantly in the air chamber served to communicate motion from the shaft to the cylinder, and to bring about the ascent of the buckets. When the action that was exerted upon the tightener ceased, the buckets descended of themselves to the bottom of the shaft. Two chambers of smaller dimensions adjoined the central one on either side and communicated with it by two small doors lined with rubber; and in each of these there was likewise stationed a workman. The pipe leading the compressed air from the blast engine terminated in the central chamber. This latter was in permanent communication with one at least of the lateral chambers that served to receive the excavated material raised by the buckets. When this chamber became full of earth, the workman closed the door communicating with the central chamber, allowed the compressed air to escape, and afterward opened the external door in order to shovel out the accumulated material. During this time the second chamber received excavated material that was being continuously raised; so that while one of the chambers was being emptied the other was being filled.

On being thrown out of these chambers the material fell on to a flooring from whence it was shoveled into the cars. The masonry rose in measure as the caisson sank. When it reached the level of the air locks, these latter were raised by means of pulleys fixed to the top of the scaffolding, and the air shaft was elongated by two or three lengths of piping.

After the completion of the foundations the superstructure was put together on the banks and finally swung on to the piers, in the manner usually employed with bridges of this kind. This work was somewhat delayed by rains and other causes and was not finished until Feb. 5, 1880, although it was begun in March, 1879.

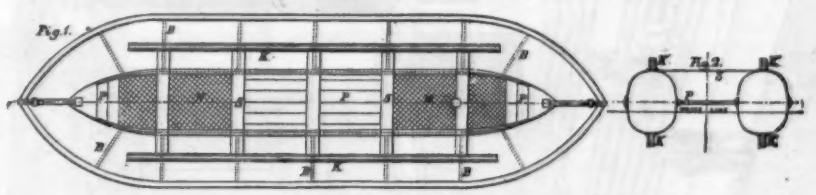
The total cost of the structure was 1,251,934.26 francs, divided as follows:

Trial pits	14,956.00
Foundations	432,494.61
Metallic superstructure	550,843.40
Masonry of the piers above ground, and of the abutments	203,262.14
Administrative labor	50,378.11

From this it appears that the viaduct cost 4,025 francs per running meter.—*Annales des Ponts et Chaussées.*

IMPROVED REVERSIBLE LIFEBOAT.

WE annex illustrations from *Engineering* of a life raft which received the first prize at the recent Tynemouth Naval Exhibition. It consists, as will be seen, of two similar hulls or tubular chambers, connected by a horizontal platform, P, along their whole length, and joined at the ends, as shown in the plan, Fig. 1. Along the top and bottom of each chamber is a strip, K, which serves either as a keel or gunwale according to which half of the boat, which is reversible, is above water. The hulls are made of 13 B. W. G. steel plates, provided with water-tight bulkheads, B, as shown. The deck is open, and for a ship's boat is made of rope network, so that it can be launched without davits, and in any position, it being a matter of indifference which side comes uppermost in the sea. For special purposes, such as the Transport Service, the boat can be made to open in half, along the horizontal axis of the hulls, so as to form rafts for artillery or troops. As a lifeboat, it was demonstrated during the Tynemouth Exhibition to be extremely efficient, not only being safe in very heavy weather, but easily handled, and traveling fast through the water. The inventors are A. Timmis and J. N. Hodgson, London.



IMPROVED REVERSIBLE LIFEBOAT.

WHEEL AND RAIL FOR COMMON ROADS.

THE combination of a wheel to be used on common roads and on a rail alternately, which we are about to describe, is already in extensive use. Though of recent introduction, in Germany it has been applied for tramways in mines, for stone quarries, brickyards, and similar purposes, wherein tram-cars are propelled by horses or human power. The plan is extremely simple, and it will at once occur that there are very many cases in this country where it could render excellent service. It is the invention of Herr Friedrich Hoffmann, of Berlin, the inventor also of the celebrated circular and regenerative kilns now used all over the world.

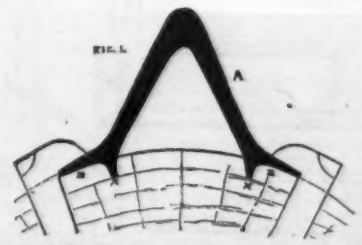
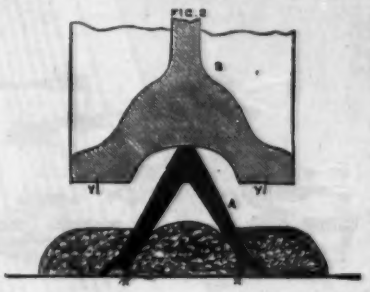


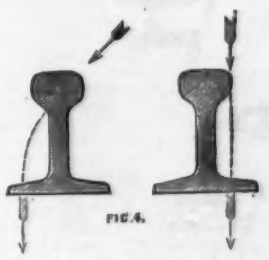
Fig. 1 shows a cross section of the rail used for light tramways. It is shaped approximately to an equilateral triangle, with the base left open. The feet, Z Z, rest on longitudinal sleepers or any other continuous support, and the clamps, X X, hold the rail firmly down. The wheels to be used in combination with this kind of rail are, as shown in Fig. 2, made with a flange on either side, and they are left loose on the axle, as with the ordinary cart or carriage wheel. The figure shows the cross section of a rail, A, and the tire of a wheel B, running thereon. The flanges, Y Y, of the wheels are made sufficiently wide to allow the trams to be used alternately on a common road without rails. The feet of the rail are, in this instance, bedded in concrete laid on brickwork. For railways worked by locomotives, the rail is to be provided with a broad head, A, as shown in the cross sectional Fig. 3, drawn to a smaller scale.

The considerations which have led to the design of this shape of rail are indicated in the sketch—Fig. 4—of an ordinary foot or Vignoles rail, in which the arrows point to the principal modes in which the vertical and lateral impulses tend to deform it. In Fig. 5 is seen how these stresses act upon the Hoffmann rail. There can be little doubt that this new form of rail is better adapted to withstand such pressures than the old shape. Consequently for the same work



the new rail may be made much lighter. The rails of our ordinary rail and tramways, resting on transverse sleepers, must be made of such strength as not to be bent between the two adjoining sleepers by weights passing over them. With the Hoffmann rail resting on longitudinal sleepers, or on any other continuous support—as, for instance, a brick pavement, on which the rail may be fastened with Portland cement—there is no tendency to deflection, as the pressure on the rail is transferred directly to the ground. Experience shows that this rail may be made much lighter for the same load.

It is well known that the inventor of the foot-rail, the late Mr. Vignoles, originally designed it with the intention of using it on longitudinal sleepers, and his first railways were laid down on this plan. It was mainly the necessity for keeping up the exact gauge that led to the adoption of transverse sleepers. Wheels with one flange require an exact gauge and a firm union with the axle. It is evident that tram-cars with wheels left loose on the axle are much easier moved than if the wheels were fast. This is, of course, more especially the case on curves, where one of a pair of common railway wheels must necessarily slip on the rail. The same, in a less degree, takes place on the straight line, and consequently the wear of the wheels as



well as of the rails of ordinary railways is very considerable. There is almost constant torsion in the axles, and a resulting continuous vibration of the carriages. Such strains all absorb tractive power. These disadvantages must in time be universally acknowledged, and it is only the enormous outlay involved in radical changes that could outweigh the resulting advantages. For the very different case of narrow gauge lines, or of tramways, etc., adoption is easy. A Hoffmann rail for tramways, suitable for carriages weighing

about one ton, weighs only about 4 lb. to the yard. An actual trial has shown that on a level line of draught one horse is able to pull a net load of from 20 to 30 tons. Nine trucks, each laden with ¾ of a ton of sand, were easily pulled up an incline of 1 in 60 by one horse. A net load of $9 \times \frac{3}{4} = 6\frac{3}{4}$ tons, taken up a gradient of 1 in 60, is equivalent to about 30 tons on the level.—*The Engineer.*

THE NEW PALACE OF THE INTERNATIONAL EXHIBITION OF FINE ARTS, ROME.

THE NEW PALACE OF FINE ARTS AT ROME.

THIS magnificent structure is at last so far completed as to be thrown open to the public, and was inaugurated on January 21st last with great pomp and many attractive ceremonies. We give an engraving of one of the principal fronts of the building, for which we are indebted to *La Ilustracion*, of Madrid.

The Palace of Fine Arts is intended to form a permanent international exhibition, where the choicest works of painting, sculpture, architecture, and industrial arts will be accessible to the people.

For the great purposes of this exposition a portion of the garden of the Quirinal was set apart to the extent of about two hundred and fifty thousand square feet, and here this most beautiful Palace of the Fine Arts has been erected. The building itself covers a space of about seventy thousand square feet; and connected with it by covered ways are various saloons in the grounds.

The architectural plans for the new palace were the result of a general competition of the Italian architects. Fifty-five plans were presented; the prize for the best series of plans was awarded to a young architect named Piacentini; his design was adopted and he was placed in charge of the work. The corner stone was laid in August, 1880, by the King, who took great interest in the enterprise, and on January 21, 1883, the exhibition was formally opened by his Majesty King Humberto. Queen Margarita, the young Prince of Naples, members of the royal family, and a great host of national and foreign dignitaries were present at the ceremonies, which were concluded amid much popular enthusiasm.

The principal facade of the building is in the Corinthian style of architecture. The grand central arch is of magnificent proportions, richly adorned with marblized columns. The edifice has neither balconies nor windows, but like other celebrated museums is lighted wholly from the roof. When adorned with marble statuary, which is to take the place of the sketches now temporarily placed, it will present a beautiful appearance. At the portico of the palace are the four principal statues, of great size, representing Architecture, Painting, Sculpture, and Industrial Art. The twelve statues of lesser dimensions which adorn the Palace are Luca della Robbia, Phidias, Apelles, Apollodorus, Bramante, Michael Angelo, Raphael, Rembrandt, Bernini, Canova, Delaroche, and Benvenuto Cellini. The crown of the Palace is a splendid group by the sculptor Adalberto Cencetti, elevated seventy-five feet and symbolizing Art, having at her side Peace and Study, which are necessary for the glory of the artist. From the portico we enter the great glass covered rotunda; here radiate six magnificent saloons, filled with the most glorious productions of eminent painters. From the rotunda, by another great saloon we enter the winter garden, which is in fact a magnificent saloon, with a crystal ceiling of immense height. The walls are provided with innumerable niches, destined to receive the finest statues, whose authors will be able to give them whatever depth of color they prefer.

A monumental stairway of stone and marble, of richest workmanship, gives access to the second department of the exposition, which is arranged, like that already described, with central rotunda and radiating saloons. Here are collected the most gorgeous ceramic objects, bronzes, marbles, mosaics, glasses, and thousands of precious works from all parts of Italy.

PRACTICAL METHODS OF INTENSIFYING GELATINE PLATES WITH SILVER.

PREPARE a silver solution as follows:

No. 1.	Silver nitrate	1 ounce.
	Water	12 ounces.
No. 2	Potassium bromide	½ ounce.
	Water	2 ounces.
No. 3	Thiosulphite of soda (hypo)	2 "
	Water	6 "

Add No. 2 to No. 1, and after washing the precipitated bromide thoroughly by decantation, dissolve it with agitation in No. 3. The muddy liquid thus obtained is either filtered *perfectly clear* or placed aside for a day, and the clear solution siphoned off: it is then made up to sixteen ounces with water and kept for use.

Method No. 1, with Pyrogallic Acid.—To intensify a plate wash pretty thoroughly after fixing, and, taking it on a pneumatic holder, flood with the following mixture:

Pyrogallic acid	4 grains.
Water	2 ounces.
Silver solution	1 drachm.

to which is added immediately before use about half a drachm of dilute (1 to 8) ammonia. It is impossible to give the exact quantity of ammonia, as it appears to vary considerably with the temperature of the solution and other slight differences. If the silver show no tendency to reduction, add more ammonia, and if be thrown down immediately, use less; with a little experience the appearance of the liquid shows when sufficient is added. Obviously, the requisite quantity of pyrogallic acid and ammonia can be taken from the ordinary developing solutions. A small quantity of soluble bromide added with the ammonia does no harm; and if glycerine be present, as in Mr. B. J. Edwards' formula, it is a decided advantage. The plate should be gently rocked, and fresh solution poured on as the image gradually increases in density. If not sufficiently dense, and the solution be muddy, rinse the plate and use fresh. When the required density is obtained rinse the plate, place it for a short time in the fixing bath, and finally in the clearing bath.

As might be expected from this mode of procedure, the pyro has a great tendency to stain the film yellow. Now, while this can be removed in the alum bath, "prevention is better than cure;" and by employing pyro, preserved in sulphite of soda, as described by Mr. H. B. Berkeley, a beautiful intensifier is obtained.

Method No. 2, with Ferrous Oxalate.—Immerse the washed plate in the silver solution and leave it there for five minutes; take out, drain, and flood with an ordinary oxalate developer, when the image will rapidly increase in density. Rinse the plate and place in the fixing and clearing baths for a short time, as before. If the plate only require slightly intensifying, dilute the silver solution more or less, as desired.

Local Intensification.—This, with a little care, can be readily accomplished by several devices. Thus, in the first method, if a little of the fixing bath be applied with a soft sponge to those parts of the plate which are sufficiently dense, on applying the solution only the remaining portions will be intensified; and by the second method, after soaking the plate in the silver solution allow it to drain, wash off the silver with the hypo-moistened sponge from the parts desired, as before, and on applying the developer you get local intensification *ad libitum*.

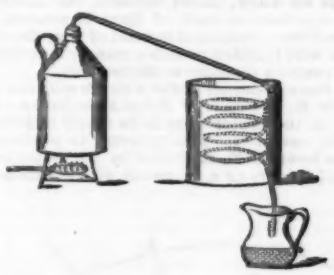
Note.—There is no limit to the amount of density that can be obtained with either method; both are applicable to either pyro or ferrous oxalate development. A trace of hypo in the film, instead of causing red fog, as in the ordinary method, *prevents it* in this case, so is an advantage; but if present in any quantity, the intensification is also prevented.—*E. Howard Farmer, in Br. Jour. of Photo.*

COLLECTING AND WORKING-UP PHOTOGRAPHIC RESIDUES.

As a good deal of interest has been taken in the treatment of residues of late, we make no apology for concluding this series of lessons by describing the processes proved to work best in practice. We shall consider the subject under five headings, viz., alcohol, gold, oxalate, platinum and silver.

Alcohol.—Now that this liquid is being used so extensively for precipitating gelatine emulsion, hardening and facilitating the drying of gelatine plates, it is very important that photographers should know how to recover the alcohol for future use. The desired result may be obtained either by treating the dilute alcohol with dry potassium carbonate, or by distilling the liquid over quicklime. In the first process, the potassium carbonate forms with the water a saturated solution which will not mix with the alcohol, thus allowing it to separate, and from its low specific gravity rises to form an upper liquid. The alcohol is drawn off by a siphon, and the solution of potassium carbonate evaporated down ready for future separation. The objection to this process is that it does not free the alcohol from all the water, and is very liable to leave certain impurities still dissolved. Although the alcohol might be used with impunity for precipitating gelatine emulsion, the liquid would not be sufficiently pure for a great many photographic processes; it is therefore preferable to purify all alcoholic residues by distilling over lime.

For alcoholic distillations, an apparatus consisting of a tin oil-can of suitable size, fitted with a perforated cork, is required. A piece of lead pipe half an inch in diameter, and about six feet long, one end of which is inserted in the perforated cork, while the other end is bent into a spiral, serves to condense the liquid. The spiral tubing is placed in a small tub or barrel having a hole just large enough to admit the end of the tubing (see figure).



The alcohol residue mixed with an equal weight of fresh quicklime is placed in the tin can on a sand bath or a saucepan of water, and heat applied, when the pure alcohol vaporizes and condenses in the spiral tubing. The vessel inclosing the spiral must always be kept full of cold water, the warm water being occasionally drawn off from the surface, while cold water is added down a tube at the bottom. Alcohol purified in this way contains about five per cent. of water, and is quite strong enough for all photographic purposes, except for the manufacture of collodion.

Gold.—Most photographers neglect the gold contained in old toning baths, on account of the small amount contained therein, and no doubt in small establishments it is hardly worth troubling about, but in large establishments, where a great deal of silver printing is done, the collection of residues should always be attended to. A large barrel, tub, or wedge shaped tank (see figure) should be set apart, wherein all used

SECTION OF RESIDUE TANK.

toning baths are collected, and when the vessel is full, a solution should be added, containing about thirty grains of protosulphate of iron for every gallon of the residue contained in the tank. After allowing the liquid to stand for about twelve hours, the supernatant liquor must be drawn off by a stopcock or a siphon, leaving the residue of metallic gold, together with waste liquor to the depth of three or four inches. The remaining liquor and precipitated gold should be thrown on a filter of bibulous paper, washed by pouring hot water over it, and, when dry, the gold is ready for conversion into chloride in the manner previously described.

Potassium Oxalate.—The ferrous oxalate developer, when once used, is generally thrown away; yet how often we hear photographers cry out at its expense; but if attention is given to reconverting the used solution into potassium oxalate, the developer will be far cheaper than any other. Either caustic potash or potassium carbonate will decompose the oxalate solution, but we prefer to use the latter compound.

The solution to be acted upon should be placed in a large beaker, and sufficient quantity of a saturated solution of potassium carbonate added till no further precipitate of carbonate of iron is produced; the solution must then be filtered through bibulous paper, and should appear perfectly colorless. If the solution is still tinted brown, it shows that the whole of the iron has not been precipitated, and that the addition of potassium carbonate and the process of filtering must be repeated.

The solution of potassium oxalate thus prepared contains a certain amount of potassium carbonate, therefore a saturated solution of oxalic acid must be added to decompose the potassium carbonate, the exact point of neutrality being found by testing the solution with litmus paper. The solution should finally be evaporated down till the salt begins to crystallize, and allowed to cool; the mother liquor can be poured off ready for use and the crystals dissolved in sufficient water to prepare a "saturated solution."

Platinum.—If only workers of the platinotype process knew what a large quantity of platinum salt is wasted when they throw a used developer into the sink, perhaps they would be more careful to collect platinum residues. In the first place, it must be remembered that the prepared paper is coated with a solution containing sixty grains of the platinum salt to the ounce, and that only about one-tenth of the platinum is actually deposited on the print, while about three-fourths of the salt is dissolved, and remains in the developer. It is therefore evident that in order to obtain the greater part of the waste platinum, all that is necessary is to treat the developer with a reducing agent, such as is used for obtaining gold from its solution. The following is the method which has proved most successful in our experience: Place the used developer in a large beaker, and heat the solution over a sand-bath till nearly boiling, then add to the solution one-fourth its volume of a saturated solution of protosulphate of iron; a black precipitate will be immediately produced, consisting of pure metallic platinum. The supernatant liquid, consisting of ferrous oxalate, is carefully poured off into the oxalate residues, and the precipitated platinum, after being washed by decantation, should be either converted into chloride, or sold to a refiner.

Silver.—This element is present both in the wash-water of silver prints, and the fixing solutions used for negatives and prints. In order to obtain the silver from the wash-water, the solution must be collected in a vessel similar to that used for gold solutions, and containing two or three handfuls of common salt. When the collecting tube is full, the supernatant liquor should be poured off, leaving at the bottom the precipitated chloride of silver, which must be dried, and either sold to a refiner, or mixed with an equal weight of dried sodium carbonate and fused in a furnace, as described in the lesson on the preparation of silver nitrate.

To obtain the silver from hyposulphite fixing baths, the solution should be collected in the usual way, and precipitated by means of sulphide of ammonium. It is impossible to give any definite quantity to insure the precipitation of the silver, but three per cent. of the alkaline sulphide should be added to the ordinary fixing bath used for gelatine plates, while one per cent. of the precipitant will suffice for solutions used for fixing silver prints.

To obtain metallic silver, the precipitated silver sulphide, obtained as above, must be dried, and mixed with an equal weight of a mixture of potassium nitrate and sodium carbonate, and fused in a blast furnace.—*Photo. News.*

FIELD TELEGRAPH WITHOUT BATTERY.

IN certain special cases, under favorable conditions, the telegraph lines can be extended to battle-fields. However, notwithstanding their lightness, they cannot be moved easily enough to follow up the maneuvers, and very frequently their fragility would render their preservation a matter of great difficulty in the midst of military operations.*

On the other hand, it must be admitted that it would be useless and impossible to use the telegraph at a distance less than six kilometers from the front of an army in action; useless, because it would be quicker to send messengers; impossible, because it could not be worked under fire. However, for communication between the main guard and the sentinels, or between the batteries and the posts of observation, endeavors have been made to fit up light telegraphs, capable of being conveyed by a few men; these may be called advanced post telegraphs. Each installation generally contains one kilometer of cable, which enables lines two kilometers in extent to be filled up between two stations.

At the time of the discovery of the telephone it was thought that this new instrument was destined to take the place of these telegraphs. But the experiments during the Russo-Turkish war soon showed that the noise of an army almost always, except in the silence of the night, prevents the voice from being heard. The most perfect telephones were, however, known at that time, those constructed by Siemens, at Berlin, and by Gower, at Paris.

The microphone even does not amplify the sounds sufficiently to render them perceptible under all conditions. It requires a battery, which is cumbersome and necessitates a certain regulation of position in relation to the vertical, which is inconvenient. Finally, it must be placed on a fixed stand, for it produces deep sounds when vibrations are communicated to its support. It has, therefore, been rejected altogether; as to the telephone, it has been admitted that under certain conditions it can be of service, and in the greater number of armies it has been added to the light telegraphs already in use. The following are some of the different systems.

A.—SYSTEMS WITH PERMANENT SIGNALS.

I.—*The Prussian Telegraph of Bückoltz*, employed by the Company of Belgian Campaigning Telegraph Operators. This apparatus has a return wire and is worked by a continuous current, *i. e.*, when there is no transmission, the current passes through the line and gears the clockwork mechanism: the signals are then produced by the interruption of the current, which throws the mechanism out of gear. Consequently, directly the cable is cut, the operators become aware of it.

The instruments work together, *i. e.*, the dispatch is recorded simultaneously at the two stations. A recent improvement enables us to pass from the continuous current to the ordinary current by means of a commutator.

A complete installation comprises:

1. A case 0·15 m. × 0·14 m. × 0·15 m. containing the galvanometer and the manipulator. The last model is somewhat larger.

2. The battery, consisting of 12 Siemens elements with sulphate of copper. It weighs 12 kilogrammes.

3. Two coils of 500 meters of cable with two wires, one carried in a sort of infantry bag, the other in a case.

II.—*The Russian System of Dereviankine* is very similar to the above; the earth is employed as return conductor.†

Remarks.—The field telegraphs of Bückoltz and Dereviankine are the only ones that give permanent signals. They are excellently arranged; we think it would be impossible to condense any further the component parts, which are essential if we wish to keep copies of the dispatches; but this

* "La Telegraphie Electrique de Campagne." By Van den Begsert, officer of the Belgian Engineers.

† Paris Exhibition of 1881, No. 1,709 in the catalogue.

does not seem to be altogether necessary. In America, on almost all the permanent lines, the dispatches are sent by sound alone, and in campaign telegraphy it is very seldom that important orders are transmitted of which it is necessary to keep a copy.

B.—SYSTEMS WITH MOMENTARY SIGNALS.

a. Optical Telegraphs.

I.—*Trouve System.*—This is only a miniature, about the size of a large watch, of an ordinary dial telegraph, with simplified mechanism. The receiver is worked by clockwork; the manipulator is worked by a button similar to that in keyless watches. The wet battery and a kilometer of cable are placed on a yoke to be carried on a man's back.*

II.—*Wheatstone One Needle System* (in use in the Spanish army).—It comprises as a receiver a vertical galvanometer, the needle of which deviates to the right or to the left, according to the direction of the current transmitted. The deviations to the left form the dots, and those to the right the dashes of the Morse alphabet. The manipulator, which resembles all those of the Morse type, is worked by reversals of the current; it is placed above the galvanometer, which is only 8 or 9 centimeters in height.†

III.—*Prussian Needle Telegraph with Earth Battery.*—This system is similar to the preceding one; the current is supplied by two pieces of zinc and copper, which are buried in the damp earth. It was used during the war of 1870.‡

Remarks.—The Trouve system is very delicate; the two others are more solid and better suited to military operations. But it is very difficult to read the Morse signals indicated by a needle, and it cannot be used at night. As a sound can be heard at any time, sounders are preferred to the above instruments.

B.—SOUNDERS.

I.—*The Caton Sounder* (employed exclusively in the military telegraph of the United States).—It is simply an electro-magnet, the armature of which forms the sounder. It is contained together with the manipulator in a little case, 0·15 m. × 0·06 m. × 0·04 m.

The battery employed contains several elements with sulphate of copper.

II.—*The Sounder of the French Army*, smaller in size but similar to the preceding one, employs a wet battery or a reversible one.

III.—*Dereviankine's Russian Sounder*, also similar to the Caton sounder, is only 0·10 m. × 0·08 m. × 0·05 m.

IV.—*The Spanish Sounder*, with dimensions similar to those of the French sounder.

V.—*The Trouve Sounder* has the appearance of a large watch. The accessories are the same as those of the portable telegraph by the same inventor.

Remarks.—All these sounders have the inconvenience of requiring a somewhat powerful, and consequently cumbrous, battery. The Trouve battery is the lightest, but the apparatus worked by it has rather a limited value. At the time when it was shown by experiment that the telephone was of little use to reproduce speech at the vanguard of an army, it was found that under the influence of battery currents, and especially of the high tension currents of induction coils, this apparatus gave sounds of great intensity. When a current is sent into the circuit of a telephone, the magnetism of the magnet which constitutes it varies, and the result is a variation in the action of this magnet on its diaphragm of soft iron. Two different sounds are then heard, one when the current is established, the other when it ceases, and thus long emissions can be distinguished from short ones, as in the Morse sounder.

In order to produce a sound of greater intensity, serving to warn the correspondent that the transmission is about to commence, the interrupted current of a little Ruhmkorff coil is employed: a continuous current can also be sent into the line, the interruptions being produced by the plate of the telephone itself, by arranging it like the armature of a trembling bell. (Captain Ferrodon's alarm.)

The instruments constructed according to the above principles are:

C.—TELEPHONIC SOUNDERS WITH BATTERY.

I.—*The Racagni-Guglielmini System.*§—These inventors arrange their induction coil either in the handle of one of the telephones, which also contains the manipulator, or on the reversible battery, which has the form of a cartridge-box. They employ an electro-chemical receiver with paper band, which seems to have the drawbacks of the Morse system without possessing its advantages.

II.—*The Mangenot System* is identical in principle with the preceding one. The battery is also in the form of a cartridge-box, and contains the manipulator and the induction coil. The inventor, acknowledging the inconvenience of his battery, which is never hermetic, and which becomes polarized, proposes to substitute for it a Clarke machine, weighing 2·5 kilos. In the event of its being impossible to hear sounds, he proposes to receive by the sense of touch, by placing the lips on the terminal of connection of the telephone. It will be remembered that a very skillful telegraph operator in 1870 received a message in this manner across a cable submerged under the Seine: but this was really a feat which would require no common degree of skill to perform.

Remarks.—All these instruments have the drawback of requiring cumbrous batteries, which the slightest accident would render useless, and which require great care. M. Mangenot proposes to substitute for them an induction machine, which is too heavy and which presents the great disadvantage of requiring a man to turn the handle. The solution of the problem must evidently be sought for among the following instruments:

D.—TELEPHONIC SOUNDERS WITHOUT BATTERY.

I.—*Colonel Jacobi's Tëlëkal.*—The complete installation comprises a long-distance telephone, and a case 0·21 m. × 0·11 m. × 0·33 m., weighing from five to seven kilos., and called the *Tëlëkal.*¶ It is furnished with a Morse manipulator, worked in the ordinary manner; by means of a little handle the manipulator can be made to ring so as to call the correspondent.

We can also employ for this purpose the trumpet call with which long-distance telephones are supplied, whether constructed by Siemens or by Gower.

The advantages of the telekal are, according to the inventor, that it can be worked without battery to considerable distances, far beyond the limit at which the voice can be heard, without being affected by the telegraphic transmissions of neighboring wires or external noises. It requires no regulation of position like the microphone, and is of great solidity.

We have in vain sought for information on the principle of this apparatus; its inventor preserves absolute silence on this subject.

II.—*The Magneto-Sounder.*—It seems to us that the telekal was still very heavy and very bulky. We have therefore sought after an apparatus which should offer the same advantages, but have less weight and less bulk. Fig. 1 represents the arrangement at which we have arrived. A

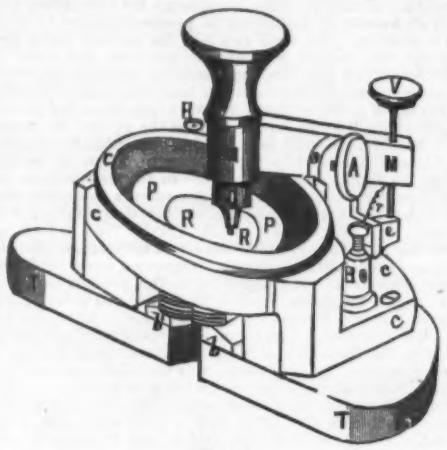


FIG. 1.

plate of soft iron, P P, is firmly fixed into a frame of copper, *c c c*, facing the poles of a flat horse-shoe magnet, T T, similar to those of the Gower telephones (*see* Fig. 2). These poles are, as we know, placed opposite one another, and very close together; on each of them is screwed a little square of soft iron, enveloped in a coil of very fine insulated wire. This wire is coiled in such a manner that the current passes in a contrary direction in the two coils.

The two free extremities of the wire are soldered on to the terminals, B B; the plate, P P, has a projection, *i. e.*, it bulges out in the center so as to be elastic under pressure like metallic castanets. This pressure is produced by a small Morse lever, M M, supported by the projection, S, of the frame of copper, *c c c*, by means of the axle-screw, A;

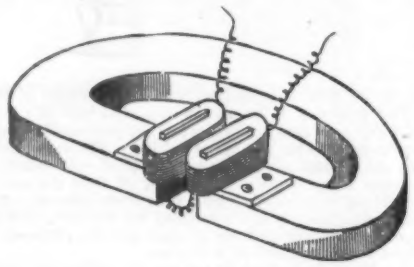


FIG. 2.

V is a regulating screw which serves to limit its play, and *r*, an opposing spring.

The apparatus thus constructed only weighs 250 grammes more than the magnet which forms part of it, or 750 grammes in all. It can be contained in a box, 12·5 c. × 9 c. × 5 c., only the button of the manipulator, and the two terminal screws, B and B', being left out.

In order to use it the terminal, B', is connected to the line, and B to one of the poles of a Bell telephone, the other pole being connected to earth, as is shown in Fig. 3. When

FIG. 3.

used in active service, the magnetic sounder is suspended on the breast by a strap, and the hilt of a sword stuck into slightly damp soil forms an earth. The operator then works with his right hand as with the Morse manipulator, and applies the telephone to his ear with his left hand. In order to make the working of the apparatus clearly understood, we must first explain that of an ordinary telegraphic sounder.

In the written Morse alphabet, the different letters are represented by combinations of dots and dashes. The telegraphic receiver reproduces these dots and dashes on a slip of paper by the pressure, more or less prolonged, of the armature of an electro-magnet, which is lowered every time the current passes through, and is raised by means of a counteracting spring. In this system .— represents *a*.

It does not work in this manner when the signal is received by the ear. The movement of the armature is limited by two stops; when it falls, it strikes one of them and produces a sound. When it rises, it strikes the other, and produces another sound. We can, therefore, note the duration of the time it is lowered; if very short, the two different sounds interfere with one another. Thus *a* is represented by $\binom{\bullet}{\times}$ $\bullet$ × if we represent by $\bullet$ and × respectively the sounds of the falling and rising of the armature.

In the *magneto-sounder* the transmitting mechanism is identical with what we have just described. When the plate is brought toward or drawn away from the coils, a current is produced in them arising from the increase or decrease of the magnetic action on this plate acting as an armature. Currents are thus sent into the line and produce sounds in the receiving telephone.

The apparatus constructed by Richez & Co., at Brussels, has fulfilled all our expectations. We have tried it on a telephonic line and were able to correspond freely. We introduced 6,000 Siemens units, *i. e.*, about 600 kilometers of telegraphic iron wire 4 millimeters in diameter into the circuit without producing any appreciable effect on the clearness of the sounds received; we had no further resistances at our disposal, but everything led us to believe that experiments made on long lines would be crowned with success. The new apparatus can, therefore, be substituted for the Morse sounder in all its applications. It has the advantage of being very light, of not requiring any battery, and of being extremely sensitive. Finally, it comprises a telephone which can be used in the ordinary manner.

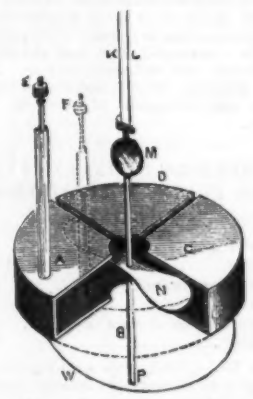
The above description of the magneto-sounder for field telegraphs is an extract from the *Revue belge d'Art, de Sciences, et de Technologie Militaires, septième année* (1882), *tome* ii., and is written by Lieutenant L. Weissenbruch.—*Electrical Review.*

THE QUADRANT ELECTROMETER.

THE immediate object of an electroscope is to *detect*, and of an electrometer to *measure* differences of potential. The gold leaf electroscope belongs to a class of instruments called by Sir William Thomson *idiostatic*, because they contain no charge of electricity which is independent of the bodies whose difference of potential they are called upon to detect or measure. Such instruments can never be rendered very delicate, for when the difference of potential to be examined is very small, the charge of every portion of the instrument will be correspondingly small, and all forces called into play will be reduced in proportion to the square of the difference of potential between the electrodes of the instruments.

The quadrant electrometer belongs to the class of *heterostatic* instruments which contain a charge of electricity foreign to and independent of the bodies to be examined. As this charge can be increased to any extent consistent with the insulation of the instrument, the forces called into play can be made sensible even when the differences of potential are very small, these forces being, for any given charge of the instrument, proportional to the difference of potential to be measured, and not to the square of the difference.

The essential parts of Sir William Thomson's quadrant electrometer are represented in the accompanying figure. The needle, N, is a piece of thin aluminum, which is frequently corrugated to increase its stiffness. A small mirror, M, is rigidly attached to the needle so as to turn with it, and the whole is suspended by means of two single silk fibers, K L, the distance between which at the top can be regulated by means of a screw. This constitutes an ordinary bifilar suspension, the weight of the suspended body tending to cause it to set itself so that the two silk fibers are in the same vertical plane. From the bottom of the needle hangs a platinum wire which dips into strong sulphuric acid, which is



contained in a glass vessel. The lower portion of the exterior of the glass vessel is partly covered with tinfoil, and this, with the inner coating of sulphuric acid, constitutes a Leyden jar, and serves to accumulate a large charge of electricity when the needle is charged. The sulphuric acid also keeps the instrument dry. The needle, N, is placed within a brass box consisting of four quadrants, A, B, C, D, each supported on an insulating glass pillar; but the quadrants which are diagonally opposite, viz., A C and B D, are connected by wires, of which the wire, W, connecting the quadrants, A and C, is shown in the figure. The quadrant, B, has been removed in the figure in order to show a portion of the needle. The binding screws in connection with the quadrants, A and B, form the electrodes of the instrument.

Before using the electrometer a positive charge is communicated to the needle, N, the Leyden jar serving as a storehouse, from which the charge of the needle is replenished as it slowly escapes. A positive charge is preferable to a negative charge, because it is less quickly dissipated from the edges of the needle. The charge is communicated to the needle through an electrode which is made to touch the wire, P, or to dip into the sulphuric acid in the jar. Before charging the needle, however, the bifilar suspension is so adjusted that the needle under the influence of the suspension and its weight alone takes up a position so that its axis is parallel to one of the divisions between the quadrants. While the needle is being charged, all the quadrants are connected by a wire uniting the electrodes of the instruments. Then, after charging the needle, its position of rest should be the same as before. If this is not the case, there is a want of symmetry about the instrument which can be corrected by causing one of the quadrants, which is made movable for the purpose, to approach or recede from the center by means of a screw. When the instrument has been properly adjusted, the needle, though strongly charged, continues to point in the same direction as before. Now suppose that the electrodes being disconnected from each other, the quadrants, A and C, are connected with the positive pole of a battery, and the quadrants, B and D, with the negative pole. Then, since the positively charged needle will always tend to pass from places of high to places of lower potential, it will tend to turn out of the quadrants, A, C, and into the quadrants, B, D. This tendency will be resisted by the bifilar suspension, and the needle will take up a position in which it is in equilibrium under the action of the two opposing couples, and for *small* differences of potential the deflection of the needle will be *proportional* to the difference between the potentials of the two pairs of quadrants. The deflection of the needle is registered by means of a beam of light which is reflected from the mirror, *m*, and received on a graduated scale.

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* See Du Moncel, "Les Applications de l'Electricité."

† "Minas Hydraulicas Defensivas," por el Coronel Scheidnagel.

‡ Laurencin, "Le Télégraphe."

§ Electrical Exhibition of 1881, Italian section, No. 1,605.

¶ See the original description by the inventor in *La Lumiere Electrique*, 3d year, No. 85.

The quadrant electrometers made in Glasgow are furnished with an "idiostatic gauge," which indicates when the electrification of the needle has attained a certain degree, and thus enables us to keep the needle always charged to the same extent, and renders the observations made on one occasion comparable with those made at other times. It is also furnished with a "replenisher," by which the electrification of the needle can be slowly increased or diminished.—*The Electrician.*

[Continued from SUPPLEMENT No. 376, page 6000.]

A REVIEW OF THE DOCTRINE OF ETHER WAVES AND OF THE MATERIAL NATURE OF LIGHT.

By ELLEN R. PRESCOTT.

IT appears generally, when rays of light pass through certain groups of isomeric compounds, that when the difference in the isomerism is due simply to the grouping of the constituent atoms, then the ray which is transmitted through the densest compound is more bent from its original course; but that when the isomerism is occasioned by a difference in the linking of atoms, then the amount of refraction depends upon the molecular structure as well as upon the density. Hence it is not only the number of atoms entering into the composition of a molecule, but the peculiar arrangement of these atoms, which determines the refractive powers of the body. Moreover, there is not only a difference in the refraction of a ray resulting from a difference in the linking of atoms, but the optical rotation, which the passage of light through fused or gaseous matter produces, depends also upon the atomic relations. These physical properties of light are invariably connected with the chemical structure of the reciprocal matter. Kundt and Röntgen have shown that in various gaseous substances and in atmospheric air the plane of polarization turns in the direction of the magnetic current. Dr. Kerr, of Glasgow, has extended this result to opaque bodies, and has found that if light be passed through a thin plate of magnetized iron its plane is rotated. Hence upon the laws of molecular combination the various phenomena of heat, of luminosity, and of chemical action depend, while the new investigations upon the production of sound by gases, and the important fact of the polarization of sound, effected by Prof. Robinson, are corroborative testimony that the phenomena of sound, as well as heat, light, and the chemical activities of matter, which are convertible into electrical or magnetic manifestations, are governed by the same fundamental law of rhythmic movement, differing in degree rather than in kind, and that the form of molecular combination is the coercive circumstance by which each separate expression is determined.

Light and heat being by this theory motions of "radiant" or, to use the more comprehensive term, *electric matter*, magnetism in effecting these movements is directly related to the matter involved. Hence when substances are undergoing chemical changes, and a magnet is brought near, the direction or lines of chemical force will be changed, while Prof. Wiedermann's experiments show that the magnetism of molecules is invariable in substances of invariable chemical properties.

Now the main proof of the electro-magnetic theory of light is that the rate of movement in light and the rate of magnetic induction approximately agree. Experiments by Cornu go to show that in air and in gases the two velocities are sensibly equal, while the differences observed in solids may reasonably be ascribed to an admissive power in certain cases because of a different arrangement of the atoms, causing a difference in the power of the molecules to oscillate in a direction producing light, while the same atoms may be so placed relatively as to propagate magnetic influence or induction.

Tribe has shown that electricity passes without alteration of direction from one electrolytic medium to another differing from it in conductivity, when the course is perpendicular to the surfaces of contact; that electricity, on passing obliquely from one medium to another, suffers refraction, and in the same plane; toward the perpendicular when from a better to a worse conductor; and from the perpendicular when from a worse to a better conductor. The refraction increases or decreases as they recede from or approach one another in conductivity. The refraction likewise increases as the incident increases.

In summing up analogies in proof of the material nature of light and of its identity with electricity in a different condition of movement, the fact that photographs, even though defective in detail, have been secured by lightning flashes proves that the actinic properties of lightning and of solar light are reducible to the same results upon chemically sensitive substances.

The interesting experiments upon the action of invisible light on photographic substances by M. Niépce de St. Victor, appear to indicate "that certain substances possess, as it were, a greater affinity for light than others—that is to say, they seem to become, during their exposure to the sun, more saturated with light than others in the same length of time, and consequently act with greater intensity on the photographic paper in the dark." That M. Niépce succeeded in "bottling up light" by exposing sensitive paper to the action of light, and afterward inclosing it in hermetically sealed tubes, would in itself, with a proper definition of terms, indicate the materiality of the light. But he pushed his investigations still further, and proved that the sensitive surface of his cardboard possessed the power of abstracting the *invisible light* from the darkness of the hermetically sealed tube, which seems capable of no other explanation, when after a long time had passed, upon opening the tubes, the cardboard saturated with tartaric acid is found to act as perfectly upon the salts of silver as when first prepared. At ordinary temperature the action becomes manifest more slowly, but by increase of temperature, or in setting up chemical action by the introduction of a few drops of water, an illuminated impression of the orifice is left upon the paper in less than five minutes.

Thus the induced motion of heat or chemical action seems directly connected with the visible action of the light particles, and in these specially limiting circumstances, chemical action becomes a visible manifestation. The molecular movement sifts out from invisible combination the fine matter, whose oscillations, under varying physical and chemical relations, afford the phenomena of light, or of the other correlated physical forces.

Any reference to the chemical relations of light would necessarily be wholly incomplete without consideration of the chemistry of growth, or the laboratory processes in the leaves of plants.

A. Barthelemy, in extending the work of Graham on the dialysis of gases into vegetable organisms, substituted for the caoutchouc employed certain varieties of leaves of living plants, after they had been reduced by darkness in the winter to the condition of a pellicle endued with elasticity, and presenting little more than cuticular layer. With these membranes he was enabled to determine what he terms the admissive power of these natural colloid surfaces—the result showing a receptivity of from 13 to 18 times for carbonic acid as compared with nitrogen, and 6 or 7 times as great as when compared with oxygen. These experiments, so far as they bear upon the present subject, simply show, even while existing abnormally, the exquisite adjustment of leaf structure to the chemical action involved. The point which concerns us is the active agent or element in the decomposition of carbonic acid. In 1872, Dr. Draper first controverted an inference, which had somehow grown into the dignity of a fact, that the chlorophyl is this chemical agent, and referred to the fact that etiolated plants decompose carbonic acid, *and then turn green.* The chlorophyl thus produced is the effect of decomposition, not its cause, and he very clearly puts it: "That as nothing can act before it exists, and nothing originates itself, the continued increase of chlorophyl shows it to be a result of previous action, and that the force decomposing carbonic acid does not reside in the chlorophyl, but elsewhere, in the structure of the leaf."

Prof. Pringsheim has more recently and exhaustively investigated leaf structure and the chemistry of growth, making experiments with rays of light, filtered through iodine in carbon disulphide, so concentrated that only rays of lower refrangibility could pass, and found that under their action the chemical changes in the protoplasmic cells and chlorophyl corpuscles were retarded; but that, in substituting ammoniacal solution of cupric oxide and so cutting off the lower rays, these effects were rapidly and vividly produced, showing conclusively that the decomposition takes place through the agency of light. He concludes that this decomposition or oxidation of chlorophyl is a process of combustion. Having failed to discover any substance which might be regarded as the product of this combustion, he assumes that the products are given off in gaseous form; moreover, that the changes produced in the protoplasmic cell contents are the direct effects of the photo-chemical action of light, and argues that the chlorophyl acts as a protection to the protoplasmic cells against excessive oxidation, and thus governs by its absorbent properties the respiration of the plant; and that, while the processes are thus retarded, "the protoplasm of the chlorophyl corpuscles is at liberty, *under the influence of the rays which are allowed to pass by the chlorophyl*, to decompose carbonic acid and synthesize the elements of starch." Now, accepting this protection of the protoplasm by the chlorophyl and the subsequent action here explained, it is simply moving the question of ultimate combination a little further off. Dr. Draper's scientific directness aids just here. "The chlorophyl is the result of chemical action, not its cause, the previous action being due to the direct agency of light." Thus science, having found the force or motion in light, is reaching out for the atoms which, in combining, produce these results. Now, with light as a material agent, we have both the force and matter for the dissociation of carbonic acid and the consequent evolution of chlorophyl; and this, bearing in mind the known effects of light upon carbon compounds, appears a legitimate result.

If solar light be a phenomenon of electricity, and in treating of electricity we adopt the word fluid, upon which Grove reasons in the expression that "the fluid and force thus become identical," where he adduces facts upon the polar action of matter, and shows that the various changes produced must result from the adjustment of matter to matter, we reach at once a unity of force and matter. Having reasoned so far, however, we are left, just as in the gaseous theory of creation, to go behind his "initial theory of electric force" to the matter producing the force, as he everywhere shows that upon the behavior of the matter the force necessarily depends. This matter he assumes to be ordinary matter; hence, in the growth and decay of all matter, we are led directly to the conclusion that in matter finely divided and widely diffused we obtain those forces, potential and dynamic, termed electrical. For, as the quantity of matter and the quantity of force are relatively constant in the rending or severing of atoms by the slower processes of disintegration, we obtain force commensurate with the expansion, just as in the more violent electrolysis of water cited by Faraday. If the various forms of matter are the result of combination, by a resolution of the matter we obtain an elementary condition of molecular mobility. And molecular motion determines electrical phenomena; but molecular condition and behavior depend upon atomic movement; the atoms of diffused ordinary matter are, therefore, the primary electrical agents.

We are thus concerned with a study of the elements into which ordinary matter may be resolved. The newer spectroscopic analyses indicate what every intelligent chemist has long suspected: that the so-called elements are largely composite substances—elementary only in resisting known means of decomposition. That the same substance may, under different circumstances, give widely different spectra is now recognized. Mr. Lockyer's explanation upon this point is that the changes in the spectrum of a body are indications of its decomposition; the spectrum of the original substance being replaced by the superposed spectra of its constituents. That certain persistent lines of many different substances seem identical, while many supposed coincidences disappear or may be explained as being simply occasioned by impurities, which are eliminated by increasing temperature, seems to afford proof that this persistence of a line, common to two or more substances, is due to some common element in the substances compared. Moreover, a given element may offer several entirely different spectra, the changes occurring, up to a certain point, with an apparently regular system of progression, when suddenly an entirely new spectrum appears, as if it came from an entirely different element, or combination of elements.

That we can thus, with our small manipulation, produce striking changes, and even measure those beyond our making, in resolving solid matter into liquids and gases, and in breaking up gases into seeming elements, is quite appreciable; but it is beyond the reach of thought to measure even approximately these processes going on throughout an unmarked eternity in the vast nebular laboratories of space. The spectroscope is our only guide here, and a recognition of "basic lines" our ultimate knowledge. Hence a most important point in physical science was gained when, in 1868, Sir John Herschel discovered what he deemed identical or persistent lines in the spectrum of the lightning and in the spectra of nebulæ. Notwithstanding the difficulties in measurement because of the constantly varying illumination, not only in the whole spectrum, but of the relative intensities of the various lines, and the differences between these and the continuous spectrum, he determined with apparent precision by five different measurements of the principal nebular line, and from twelve nebulæ, that the nitrogen line identified by Mr. Huggins in the spectra of nebulæ is the sharply defined and conspicuous line of the lightning spectrum. Now that in fixed laboratory processes the known elements are found to give widely different spectra under changes of temperature or varying relations, it is at least presumable that the elements known only by the analogies of their spectra are subject to similar variations with the varying conditions of chemical combination. Plucker has shown that when the intensity of the induced current is increased, the green and blue lines of the hydrogen spectrum begin to broaden; and Lockyer has found that close to the sun's surface the red hydrogen line is frequently seen broadened. This he found to be due to increased pressure of gas. The action of increased electrical tension and increased gaseous pressure is here identical. Hence in the differences observed in nebular and cometary spectra, the inference is legitimate that they represent different states or stages of combination in the same elements in the massing into denser forms, and while subject in the wide sweep of orbital movement to variation in electrical tension, because of rapid approach and recession to various solar systems. The spectra of both nitrogen and oxygen change with an increase of the induced current. The change takes place quite suddenly, and is attributed to a change of allotropic condition of the gas. Now, remembering that a like result is given by an increase of electricity or of gaseous pressure, and adding these observations to the investigations by Zöllner upon the constitution of comets, it passes from a vague assumption into a legitimate deduction that the differences are simply differences in electrical condition by the increased combustion in molecular massing.

Now, therefore, visible or sensible electricity becomes so only by a combination of the elements of electricity or the electric matter of space, just as we have seen that the *invisible* light in M. Niépce's hermetically sealed tubes becomes sensible light only under the coercion of chemical combination. Light and electricity are with this view not correlates of forces acting upon and through an indefinite medium, but are the creative matter of the universe, the existence of which becomes sensible through the movement imposed by inherent attraction and repulsion.

Zöllner's description of the "electrical constitution of comets," embraced three distinct forms or stages in formation: First, those small comets in which there is no development of luminous matter, upon which the sun exerts a visible repulsion. Second, those comets in which is observed a repulsion upon the train or tail, while no sensible action of repulsion is manifested by the nucleus itself, the comet passing in its orbit with a planetary movement, held by equalized forces, while the tail sways in its wide sweep like the white wand of Prof. Crookes' vacuum tubes under magnetic influence. This was seen in the comet of 1807. His third division is of those comets more frequently seen, where a repulsion is observable not only in the sun's action upon the tail, but where a similar repulsion exists between the nucleus of the comet and the surrounding luminous matter which forms the tail; as is shown by the dark, apparently empty space immediately surrounding the nucleus, as in the comets of 1665, 1680, 1744, 1769, and 1811, the appearance of the tail in each case, from its transparency, and the total absence of refraction was that of simply illuminated aqueous vapor. Moreover, he concludes that the dark space is not a simple negative result of shadow from the head of the comet, but is a condition of darkness owing to the constitution of the "atmosphere" inclosed between the nucleus and the luminous walls beyond which the tail extends. Now, referring again to Prof. Crookes' so-called vacuum tubes, and to the explanation of the luminous wall surrounding the dark space of the negative pole beyond the limit of repulsion, we find that the negative electricity driven off in straight lines from the pole manifests itself first as light at the point where repulsion ceases, and collision with its consequent vibratory movement supervenes. It is, therefore, in the first massing of this electric or radiant matter by chemical action that the matter takes up the movement which we call light.

Accepting, with Zöllner, the theory that comets are of electrical constitution, the analogies are not far to seek in the attractions and repulsions set up in the tenuous matter of the partially exhausted tubes. There are miniature comets of the physical laboratory as well as the miniature auroræ described by Mr. Capron, and both are the result of the electro-chemical polarity of the residual gases of the tubes. The negative pole acts with a projectile force under electrical tension, the molecular discharge being necessarily dependent upon the strength of the current. In like manner the head of the comet becomes a reservoir of force from the activities of the matter gathered in the wide sweep through space, while the electrical repulsion manifested is the direct result of the chemical combination of elements thus brought within the range of atomic action, the quantitative relations being invariable.

The luminosity of the exhausted tubes appears to be due to the persistent presence of hydrogen, as in Prof. Crookes' experiments, no degree of exhaustion prevented its reappearance upon any increase of temperature short of the fusing point of the glass; the hydrogen apparently being held in the superficial pores of the glass. Here, then, solid matter holds this light-giving element, which becomes sensible only by induced molecular movement from increase of temperature. And now, looking at the substance emitting light as hydrogen held in the pores of the glass, and keeping in view the invariable return of hydrogen apparently taking on other characteristics by varying arrangements of atoms, but reappearing as the underlying matter in the spectra of comets, nebulæ, auroræ, and the very sun himself—we are led to the doctrine first proposed by Rev. T. R. Birks in 1860, and more recently and exhaustively treated by Dr. Siemens, that hydrogen is the primary matter of interstellar space. If, argues Mr. Birks, hydrogen be the ultimate, then every other element is resolvable into hydrogen by sufficiently powerful decomposing agents. He assumes that every atom has two electric poles, opposed and of equal force, and that one atom differs from another only in the degree of polar force, but that in the same atom there is always a balance of polarity. At this point, however, he introduces an ether for the transmission of the attractions and repulsions of the matter. To this ether, as a mere means of conveyance of the motions of the matter, he denies necessarily the polarity of the atom. Now, if in the processes of combination there is, according to the new chemistry, a single linking of atoms and various forms of multiple grouping, there will be presumably in the transposition of atoms residual or uncombined portions, and these being endowed with the same properties of motion will maintain a correspondence of movement with that of the combined atoms. The communication of these properties will, therefore, be

not a transmission by a receptive medium, but an actual community of motion. And this view receives support from the universal establishment of electric currents and the phenomena of electro-magnetism. Every atom is thus a magnet from its structure and from the imposed movements.

The coincidence of theory with Dr. Siemens and Mr. Birks, is in this law of magnetism as applied to the mechanical energy which the sun exerts.

By virtue of its revolution, the sun forms a vast magnet, and a special repulsion propagated through the plane of the equator must be compensated by a special attraction in the line of the poles. The mechanical energy which is thrown off continually in light and heat would otherwise lose itself in space, unless there is a return by a cosmical circuit to the sun. This movement, which Mr. Birks attributes to ethereal force, but which Dr. Siemens, on the other hand, considers as the passage of fine matter—of hydrogen, oxygen with carbon compounds—diffusing itself in swift undulations to the verge of the solar system, and which, in following the law of magnetic currents, travels at right angles when this impulse ceases or grows feeble, and returns to the center in the line of attraction of the solar axis. The ethereal force is thus the product of the matter, and inseparable from it. This view, continues Mr. Birks, seems to meet with a partial indirect confirmation in a singular astronomical fact. The orbits of the planets and their satellites in general lie near to the plane of the ecliptic; but the satellites of Uranus, the outermost planet, except Neptune, are a remarkable exception. They are inclined at an angle 71°, and since their motion is retrogade, 102° may rather be viewed as the true inclination. We may, therefore, infer that the directive force at the distance of Uranus is no longer in the ecliptical plane, but more nearly at right angles. We should thus have reached, or nearly so, the middle stage in a grand cosmical circuit, where the energy emanating from the sun in the plane of the equator begins to travel at right angles that it may return at length in the line of the axis to the center again. Dr. Siemens points out the analogy existing between this vast cosmical movement and the lines of force in terrestrial magnetism. We are not here concerned in the present discussion of scientists as to where in space solar radiations are expended in thermal changes in the dissociation of the diffused matter, as the result would be the same, and the conservation of solar energy would equally result from this process, whether effected in the sun or in the outer regions of space. But that the sun gathers up by polar force the denser fuel, and throws off the elements to be rekindled somewhere at a later period, seems as obvious as that the peat bogs pack the sunlight which burns out later on the hearthstone.

Meteorological indices of magnetic and electrical disturbances, of periodical variations in temperature, the differences in annual rainfall, cyclones, and even those varying phases of vital phenomena which are shown by periodicity in the rates of multiplication of certain forms of animal life, as in "locust years," etc., each following in due sequence the sun spot period, lead us, *a priori*, to a co-ordination in these electrical and vital relations with solar conditions.

Henri Becquerel's theory, that "hydrogen conveys electricity to the earth through planetary space," is thus a repetition of Newton's doctrine, as cited by Dr. Sterry Hunt, of interstellar matter made up of emanations and exhalations from the atmospheres of suns, planets, and of comets, that this interstellar medium contains the "material principle of life" "and the food of suns and planets," being copiously absorbed by the sun "to conserve his shining."

Prof. Graham suggests, what Mr. Lockyer bids fair to prove, that the various kinds of matter recognized as elementary may possess one and the same ultimate or atomic nature, existing in different conditions of movement. With the atom at rest, the uniformity of matter would be perfect; but it always possesses motion as an inherent property, and as differences in the amount of this motion occasion differences in volume, matter only differs in being lighter or denser matter; or, in other words, matter takes on motion in lighter forms which it locks into the possibility of motion in denser combinations. The density of matter is thus obviously the equivalent or correlative of motion.

Now, accepting this assumption of the oneness of matter with its diversity of motion, resulting formulæ prove the conservation of energy. But while granting the restorative process of what Dr. Sterry Hunt calls the "respiration of the sun," if we follow the analogies of nature as appreciable to us, there is a gradual dissemination of the matter which holds the force, so gradual indeed as to escape human computation, for could we measure the lifetime of suns, eternity itself would take the marks of time. Moreover, were there but one sun sending his currents out to the boundaries of a planetary system, then we could upon this theory estimate an exact compensation. But these rhythmic movements of a single star are multiplied by countless millions beyond the stretch of thought, each of which sends its pulsing flood through space, while every atom of these vast tides holds the electrical properties of attraction and repulsion—these are the creative forces of nature. And if, as has been said, creation is now a continuous and enduring fact, the pale nebulæ wrapping and coiling into new worlds within the depths of space are children of the hot-breathed suns, while light is the first articulation of the law of electrical attractions which gathers them into systems, each to its kind.

EXTRACTION OF THE PRECIOUS METALS FROM ALL KINDS OF ORES BY ELECTROLYSIS.

By BLAS and MIEST.

THE authors have discovered that if, in electrolysis, compressed sulphur ores are used as anode in a bath of an electrolyte containing the same metal as the metal of the ore, on the passage of the current the ore is decomposed, the sulphur, etc., being precipitated at the anode, while the metal collects at the cathode. Thus with pure galena in a lead nitrate bath, the separation is complete and easy. If the ore contains silica as well, then the silica is deposited along with the sulphur, and remains uncombined; antimony and arsenic, if present, behave in a similar manner, being precipitated as insoluble oxides; they are very easily separated by subsequent electrolysis. When large quantities of arsenic are present, a part of it combines with the sulphur, and forms realgar or orpiment. When ores containing several metals are operated on, the precious metals, being most easily precipitated, are thrown down first in the metallic state at the cathode under the action of a moderate current. The final separation of these metals requires very little battery power, for the mass of metal, when dissolved under the action of the current regenerates sufficient heat for the ulterior separation of each metal separately. The products at the anode are extracted and purified by treatment with carbon bisulphide, and afterward by separate electrolysis. The decanted carbon bisulphide solution of sulphur is distilled, the latter being left pure. If the ore is a polysulphide, and is mixed with much iron, sulphur and iron oxide are obtained in the first operation. These are best separated by electrolyzing in a dilute sulphuric acid bath; pure sulphur is obtained at the anode and basic iron sulphate at the cathode. By this process, 1½ horsepower is required to produce 1 kilo. of copper from a sulphurous ore in one hour. As an example of the working with a complex ore, they describe the treatment of an argentife ous lead ore containing iron, copper, and zinc. The current being sufficiently strong, the iron and zinc will dissolve as readily as the other metals, but will not be precipitated so easily, therefore the solution will gradually become saturated with iron and zinc; the current is then regulated so that only the lead, silver, gold, and copper are precipitated on the cathode, while the zinc remains dissolved as nitrate. As the bath becomes saturated, the iron yields to the zinc, and is precipitated to the bottom as ferric oxide, and as soon as the solution is nearly saturated with zinc nitrate, it is siphoned off; the metals are then removed from the cathode, the sulphur and silica from the anode, and the iron oxide from the bottom, of course all separately. The sulphur, etc., and the metals are treated as above described. The zinc nitrate solution is treated with a small quantity of zinc oxide, which throws down the iron; the lead, copper, and silver retained (if any) are precipitated by passing a current through the solution, using a zinc anode.

The pure zinc nitrate may be treated by a stronger electric current if metallic zinc is required, or chemically if zinc oxide is wanted.—*Chem. News*, xlvi., 121–122.

THE ANALYSIS OF MILK.

A CERTAIN volume of milk, measured with a graduated pipette, is evaporated in a water bath, and the dry residue, after having been weighed, is treated by ether, to dissolve the fatty matter. The solution is then evaporated and weighed. From the undissolved material, which is a mixture of lactose and caseine, the lactose is dissolved out by means of water, and the caseine is collected on a filter. The caseine is then weighed in its turn, after having been dried in a stove.

FIG. 1.—APPARATUS FOR THE ANALYSIS OF MILK.

A, Gas Furnace. B, Copper Water Bath. C, D, Tubes for Renewing Water in the Bath.

I have made use of this process in the analysis of ass's milk, and, save a few modifications in details, it is the one employed in the examination of the numerous samples of cow's milk that are collected by the authorities in the markets of Paris. The object of this examination is to guarantee the consumer against the so frequent frauds to which this food product is subject. Among such frauds the most usual is the *extension* of the milk by the addition of more or less water. The weight of the residue left by desiccation in the water bath suffices in most cases to expose this mode of deception. The process is as follows:

The density of the milk, taken by the lacto-densimeter, gives a preliminary indication to set us on the track of the falsification. Then, by means of a graduated pipette, 10 cubic centimeters of it are removed and evaporated to dryness in a flat bottomed porcelain capsule that has been previously tared and numbered. This desiccation requires four or five hours. With a water bath like that shown in Fig. 1, nine samples of milk may be dried at once.

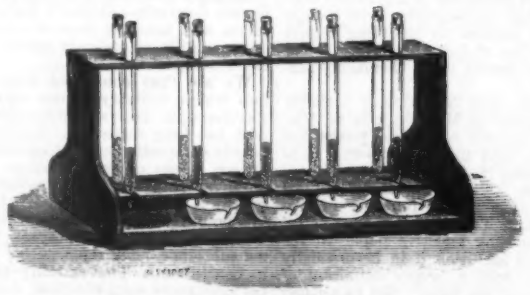


FIG. 2.—APPARATUS FOR THE ANALYSIS OF MILK.

After it is ascertained that desiccation is complete, and two successive weighings having given the same result, the residue is put by till the next day. The treatment with ether is not performed at once because the material detaches itself, when it is very dry, in scales that it is difficult to divide without loss. But, by the following day, the residue becomes less brittle on absorbing a little water, and it is then placed in a tube open at the ends, containing loose cotton at the contracted lower part, and washed three times with ether containing 10 per cent. of water (Fig. 2).

The ethereal liquid, which is received in a tared porcelain capsule, is left to spontaneous evaporation. The butter that remains after desiccation in the air and water bath is weighed, and the difference gives the lactose and caseine.

By the aid of these data is ascertained the quantity of water that, in case of fraud, has been added to the milk. It is agreed that unsophisticated milk should contain, on an average, 87 of water and 13 of dry matter. In order to know the quantity of normal milk, and, consequently, the quantity of water added, say in a sample that has furnished 10 per cent. of dry matter, we take the proportion

$$13 : 100 :: 10 : x,$$

where x equals the weight of the normal milk, or 76·9. The complement, 23·1, represents the water added.

In order to render the desiccation more rapid, and for the purpose of obtaining a residue that is more permeable to ether, the advice has been given to add to the milk an inert material, such as plaster, sand, sulphate of magnesia, etc. The substance which appears to be most suitable is the pulverulent alumina that is obtained by the calcination of ammonia alum, and 2 grammes of which are added to each 10 cubic centimeters of milk.

The proportion of lactose is ascertained with milk that has been diluted with twice its volume of water. There is no need of first separating the other elements. The reagent employed is a tartro-alkaline liquor of copper, which, under a determinate volume, is decolorized by the diluted milk introduced by means of a graduated burette. This liquor should have been previously titrated with a solution of lactose containing ½ to 1 per cent. of this substance in a pure state. The polarimeter has likewise been employed for the determination of the lactose, but the results given by the apparatus are not accurate, as the milk contains other materials that have an action on polarized light.

The presence of starch, oils, etc., is recognized by means of the microscope. The mineral substances that are added, either to increase the density or to preserve the milk for a longer time, are determined by evaporating to dryness 25 cubic centimeters and weighing the ashes; 100 of normal milk furnish 0·4 to 0·8 of grayish ashes.

The milk which is consumed in so great quantity in large centers of population is the object of numerous manipulations. At Paris the greater part of this aliment comes from the environs of the city and from localities on lines of railways within a radius of from 80 to 100 kilometers. Normandy and Brie are the two regions that furnish most of it. There are, besides, within Paris, a certain number of cow stables which, by reason of the bad feeding of the animals, give, most of them, a poor and middling quality milk.

Milk derived from the exterior, says Mr. Pabst, is rarely diluted, for it would be useless to pay freight charges on the added water. But the adulterators, who formerly were content to merely skim the milk and replace the removed butter by flour, have to-day organized into associations, each of which works within a special region. The producer brings his milk, which is then skimmed and mixed with a quarter or a fifth of artificial milk, and afterward sent to an associate or depositary at Paris, who extends it with water and sends it to the customers. Such maneuvers introduce into milk elements that are foreign to its composition. The products employed for the purpose are oils, sulpholeates, ground malt, and sheep's brain. What is important, in fact, is to give the milk the opacity and yellowish color that were due to the cream that was removed.

The oils that are frequently made use of emulsify well in milk, but they offer the disadvantage of forming small drops on the surface of the liquid when the latter is heated. Sulpholeic acid, a residue in certain operations connected with dyeing cotton, furnishes more stable emulsions. There is also much employed a "concentrated milk," which is manufactured in enormous quantities in Switzerland, and which is obtained by evaporating milk to a sirupy consistency after having added to it quite a large quantity of ordinary sugar. This is added to the milk after it has been redissolved in three or four times its weight of water. This addition is recognized by the presence of the sugar in the milk thus mixed. Lactose reduces the tartro-alkaline liquor of copper, upon which ordinary sugar exerts no action. After the interversion of the latter by an acid, its proportion, ascertained by this same liquor, may be deducted from that of the lactose which has been previously determined, and which alone pre-exists in normal milk.—*Eug. Peligot, in La Nature.*

[JOURNAL OF THE CHEMICAL SOCIETY.]

THE CHEMISTRY OF LIGNIFICATION.

By C. F. CROSS and E. J. BEVAN.

FOLLOWING the views advanced by physiologists on the chemical phenomena of lignification, we were led to forsake the incrustation theory, as not adequately expressing the facts established concerning the origin, properties, and decompositions of the lignified substance, and to adopt, as a working hypothesis, the alternative view of lignose, or bastose, as we ventured to call the jute-fiber substance, viz., that it is a chemical whole in the sense of presenting a true combination rather than a mixture of cellulose with its non-cellulose constituents. Subsequent observations have further justified this course. By means of fractional solution in the ammonia copper reagent, we uniformly obtained an amorphous modification of the fiber substance, exhibiting properties similar to the original as regards its behavior both to chlorine and to acids.

In one particular, however, a difference is observed, in that the freshly precipitated amorphous modification gives only a slight reaction with aniline sulphate, and after a second solution and precipitation no coloration is obtained. That this reaction, supposed to be essentially characteristic of lignose, is in reality due to some product of change (probably of oxidation) is further shown by the fact that this property of giving a yellow color with aniline salts is entirely lost after the substance has been boiled in a solution of sodium sulphite, the other properties remaining unaltered. We find, moreover, that a yellow reaction with aniline salts is characteristic of a number of aromatic aldehydes. If, for instance, oil of cinnamon be shaken with a solution of the sulphate, the whole solidifies to a mass of bright yellow needles. Lignose we think, therefore, is to be considered apart from this property.

We have previously shown that jute is resolved in various

ways, according to the methods or conditions brought to bear upon it, the cellulose, for instance, appearing either as cellulose or in the form of acids of the pectic class. So also the non-cellulose appears either as an astringent substance, or in the form of the chlorinated derivative previously described. In reference to the latter and its evident connection with the aromatic series, Dr. Armstrong directed our attention to the researches of Stenhouse and Groves on the chlorination of pyrogallol, as probably bearing on the subject. We prepared mairogallol according to their method (*Chem. Soc. J.*, 1875), and found that both it and the amorphous substances which constitute the chief portion of the product give, when treated with sodium sulphite solution, a color reaction exactly resembling that which is characteristic on the freshly prepared lignose derivative. A close connection of these plant-constituents with the trihydric phenols, which can be seen to be suggested on grounds which are independent of this observation, we venture to think is thereby fairly established.

Following up this subject, we endeavored to prepare a more highly chlorinated derivative of bastose. The derivative obtained by the action of chlorine gas upon bastose in presence of moisture is an amorphous yellow body, which, only when freshly prepared, gives the color reaction with sodium sulphite. Although this indicates the occurrence of molecular change during the process of purifying the body for analysis, and although its amorphous character places it in that much abused category of substances to which the ordinary criteria of purity are inapplicable, the numbers obtained in the analysis of preparations various in origin and differently prepared were constant, and agreed with those required by the formula $n(C_{12}H_{11}Cl_4O_9)$. In justification of the adoption to this formula we would state, first, that it was our only guide in investigating the constitution of lignified fibers, and secondly, that substances which go to build up living tissues are of very necessity colloids, and their immediate derivatives also; but because colloids they are none the less definite, and at all events the method of ultimate analysis must be applied to their investigation until it is shown to be nugatory.

The chlorinated compounds experimented upon were obtained, the one from jute and the other from the fiber of *Musa paradisiaca*, a monocotyledonous plant. The purified fibers were exposed in the damp state to an atmosphere of chlorine gas, and the reaction being complete, the products were severally dissolved away by means of alcohol, precipitated with water, washed and dried first in a vacuum and lastly at 100°. These were then separately dissolved in glacial acetic acid, and further chlorinated after the manner described by Stenhouse and Groves. The products were separated by pouring the acetic solution into water, whereby they were precipitated in the form of a yellowish white substance resembling wax. After washing and drying, first in a vacuum, and lastly at 100°, they were analyzed, with the following results:

(*a.*) From jute. (*b.*) From Musa.

(*a.*) 0·4087 gave 0·5550 AgCl.
0·1234 " 0·1788 CO_2 and 0·0435 H_2O.

(*b.*) 0·4892 " 0·6689 AgCl + 0·0060 Ag.
0·1790 " 0·2611 CO_2 and 0·0564 H_2O.

	(*a.*)	(*b.*)	Calc. $C_{22}H_{44}Cl_{12}O_{18}$
C	39·52	39·77	40·0
H	3·92	3·50	3·8
Cl	33·50	34·20	34.0

The products are therefore identical. It is impossible to account for their derivation from the original tetrachlorobastin (which we may represent by the formula $C_{22}H_{32}Cl_4O_{14}$) by a symmetrical equation. At present we cannot do more than record the results as they stand.

Starting, indeed, with a highly complex molecule, such as both bastose and the lower chlorobastin certainly are, and in view of the further complicating action of chlorine upon the trihydric phenols and their derivatives, which has been established by the work previously cited, we have no reason to expect a resolution into simpler molecules by means of this reaction. It would appear that only in the absence of oxidizing conditions can this be effected, and it is from this point of view that we are following up the resolution of bastose, lignose, and the chlorobastins by means of the sulphites under extreme conditions of temperature and pressure.

Note on the Constitution of Lignose.

We would record two recent observations which bear upon the question of the mode of union of the constituents of lignose. (1.) Dry chlorine has no action upon this substance, whereas the presence of moisture determines instant combination, with evolution of heat. (2.) The furfural-yielding constituent survives exposure to chlorine, the chlorinated jute fiber giving an abundant yield of this aldehyde by distilling with hydrochloric acid.

In conclusion, we wish to express to Sir Joseph Hooker and Professor Thiselton Dyer our recognition of the privilege of occupying the Jodrell Laboratory for the purpose of carrying out these researches, and our sincere thanks for their personal kindness to us during our stay.

ADDENDA.

Note on the Sacchulmic Compounds.

Sestini has recently published (*Gazzetta*, 1882, 292; *Chem. Soc. J.*, 1882, 1,182) the results of an investigation of the action of the halogens upon the sacchulmic compounds, and we wish to call attention to the similarity of the products obtained by him to those which we have obtained from various substances of vegetable origin. For instance, the chloroxysacchulmide, $C_{22}H_{18}Cl_4O_{13}$, described by him is closely similar to the derivative obtained by chlorinating the black substance formed by the action of H_2SO_4 at 60° to 70° upon the carbo-hydrates, one preparation of which we analyzed and found to be $C_{22}H_{18}Cl_4O_{13}$ (*Chem. Soc. J.*, xl., 1,122): these two derivatives are in their properties identical. The resinous matter obtained from the alkaline liquors from esparto boilers yield a series of chloro derivatives similar in composition and properties to the above, and generally the products of degradation of the carbo hydrates, natural and artificial, yield chlorine substitution-products having similar characteristics. Should the presence of an aromatic group in these compounds, of which there appears to be some evidence (*Jahresb.*, 1871, 741; 1872), 771, be established, Sestini's results will throw additional light upon some of the difficult problems suggested by the changes which the carbo-hydrates undergo in plant tissues.

(2.) Since reading this paper we have found that * Dr. Muller has preceded us in the observation that the reaction of aniline sulphate with lignified fibers, formerly supposed to be characteristic of lignose, is in reality due to some product of its change; this be succeeded in removing by means of *oxidizing* agents, such as Schulze's solution, and dilute solution of chromic acid.

We do not appear to have been singular in overlooking this observation of Dr. Muller's, and we are glad to be able to reproduce it, and add the confirmation afforded by the observations in this paper

* "Pflanzenfaser," foot-note to p. 11.

On the Oxidation of Cellulose.

By C. F. CROSS and E. J. BEVAN.

On boiling cellulose with nitric acid (60 per cent.), it is slowly converted into oxalic acid. This decomposition may, however, by careful observation, be seen to take place in three stages. In the first place, the cellulose is thoroughly disintegrated, the change doubtless resulting in the formation of hydrocellulose (Girard, *Ber.*, ix., 65). Oxidation of this into oxalic acid then ensues. A portion of the mass, however, yields but slowly to the action of the nitric acid, in consequence, as we find, of its conversion into an oxydized derivative, to which we have provisionally given the name *oxycellulose*. The quantity of oxycellulose produced appears to be about 30 per cent. of the cellulose acted upon. When thrown upon a filter and washed with hot water, the removal of the acid is attended with gelatinization of the mass. In this state it is entirely soluble in dilute alkalies, and is precipitated from such solutions unchanged and in a form resembling pectic acid, on the addition of acids, and also of alcohol, saline solutions, or even strong solutions of the caustic alkalies. Observations of the composition of these precipitates showed that oxycellulose does not form compounds with bases, or at least only of a very weak order, the substance thrown down by alcohol or saline solutions retaining only traces of inorganic matter. Specimens of oxycellulose obtained from various sources and purified in different ways were analyzed, after drying at 110°, with the following results:

(*a.*) Prepared from cotton, dissolved in NaOH, precipitated with $BaCl_2$, and washed.
(*b.*) Prepared from jute, dissolved in NaOH, precipitated by HCl, and washed.
(*c.*) Prepared from jute, dissolved in NaOH, precipitated by HCl, and washed.
(*d.*) Prepared from pith of *Aralia papyrifera*, analyzed directly after washing.

a. 0·1756 gr. gave 0·2779 CO_2 and 0·0840 H_2O.
b. 0·1329 " 0·2121 " 0·0642 "
c. 0·1018 " 0·1617 " 0·0504 "
d. 0·1388 " 0·2200 " 0·0689 "

	a.	*b.*	*c.*	*d.*	Calc. for $C_{12}H_{20}O_{10}$.
C	43·16	43·53	43·32	43·23	43·40
*H	5·20	5·36	5·50	5·51	5·22
O	51·64	51·12	51·18	51·26	51·38

Oxycellulose dissolves in concentrated sulphuric acid with a pink color; the dissolved body, when isolated, is found to be dextro-rotatory, and otherwise similar in properties to ordinary dextrin. The freshly prepared oxycellulose is not colored by iodine or by Schulze's solution, but the horny mass to which it dries is colored deep blue by the latter. These facts, together with the formation of the "nitro"-body about to be described, establish the cellulosic character of oxycellulose. The "nitro"-body was prepared in the following way: The gelatinous oxycellulose was washed with strong nitric acid until free from water, and was then diffused through a mixture of equal volumes of strong sulphuric and nitric acids, in which it quickly dissolved. The solution, after standing for about an hour, was poured in a fine stream into a large volume of water, by which the "nitro"-body was precipitated as a white flocculent mass. The product, after drying at 110°, was analyzed according to Eder's method (*Ber.*, xiii., 169), with the following result:†

0·2342 gramme gave 25·20 c. c. NO at 770 mm. and 19·4° C.

Percentage of N.	Calc. for $C_{12}H_{22}O_{10}3(NO_3)$.
6·48	6·63

Our object in studying this resolution is to contribute to the solution of the problem of the constitution of cellulose. The decompositions of cellulose, including the above, go to show that it is made up of a nucleus which exhibits considerable stability, and side groups which easily yield to oxidation, and whose removal appears to cause only a subsidiary change in the composition or properties of the original. We have commenced the study of the oxidation of cellulose, in presence of alkali, by means of permanganate; and in addition to products of low molecular weight, we have obtained a body exhibiting the characteristic properties of metapectic acid, a result which is in confirmation of the above hypothesis.‡

* Allowing for ash.

† We think it worthy of record that in a second determination by this method, with a larger quantity of substance (0·801 gramme), when about 80 per cent. of the total NO had been expelled, the flask containing the boiling ferrous sulphate solution was shattered, with a violent explosion.

‡ Comp. H. Müller, "Pflanzenfaser," p. 15.

The Analysis of Certain Plant Fibers.

By C. S. WEBSTER.

At the instance of Messrs. Cross and Bevan, I undertook the extension of the results obtained by them in the investigation of the jute fiber to a series of the more commonly occuring plant fibers, and the main results of this work are embodied in the following table.

The reactions of these fibers, which also form an essential feature in the diagnosis of their constitutions, are detailed below:

Ammonio-copper Reagent.—These fibers without exception dissolve, more or less rapidly, in contact with metallic copper and strong ammonia. The conflicting impressions which prevail on this point are doubtless referable to the employment of this reagent in its several forms, and to the widely different activities of these.

	Fibro-vascular bundles of monocotyledonous plants.					Bast fibers of dicotyledonous plants.					
	Agave Americana.	Yucca gloriosa.	Ananassa sativa (pine apple).	Musa paradisiaca (Manilla).	Phormium tenax (New Zealand flax).	Boehmeria puya.	Urtica heterophylla (Nilgherry nettle).	Crotalaria juncea (Sunn).	Hibiscus strictus.	Linum usitatissimum (flax).	Corchorus capsularis (jute).
1. Yield of cellulose (Cl method)	81·2	80·8	76·3	62·8	86·3	83·8	95·0	76·9	63·0	82·0	75·0
2. Character of isolated cellulose	Fibers free.	Fibers free.	Fibers agglutinated.	Fibers agglutinated.	Fibers partially agglutinated.	Fibers partially agglutinated.	Fibers free.	Fibers free.	Fibers partially agglutinated.	Fibers free.	Fibers free.
3. Loss in boiling 1 p. c. HKO (5 minutes)	9·9	14·5	9·6	18·6	5·8	15·6	2·6	5·3	13·7	7·8	17·2
4. Ditto (60 minutes)	14·6	16·5	19·0	31·7	9·9	24·1	7·3	10·7	25·5	16·6	18·6
5. Ash	1·0	1·3	1·0	1·6	0·9	3·7	1·0	0·9	2·0	1·7	1·1
6. Aggregate elementary composition. C	45·9	—	42·5	42·6	44·4	41·8	42·9	—	—	43·7	47·1
6. Aggregate elementary composition. H	6·1	—	5·6	5·6	5·9	6·0	5·9	—	—	5·9	5·9
7. Lignified or otherwise	Lignified.	Lignified.	Lignified.	Lignified.	Lignified.	Not lignified.	Not lignified.	Lignified.	Lignified.	Not lignified.	Lignified.

The specimens of fibers were obtained from the Museum at Kew Gardens.
Whole length samples were taken; purified by boiling in glacial acetic acid and afterward in alcohol; dried at 100°.

Nitric Acid.—(In presence of sulphuric acid.)

The substance of all the above fibers is converted by the action of the usual nitrating mixture into so-called nitro derivatives, allied to the pyroxylins.

In the case of the lignified fibers, the reaction is accompanied by the development of a mahogany-red color, which on washing gives place to the bright orange of the nitro-derivative in question.

Sulphuric Acid (conc.).—The fibers of *Boehmeria* and *Urtica* dissolve to colorless solutions; the solutions of the others are more or less dark colored.

Chlorine Gas.—Chlorine substitution derivatives are obtained from the fiber substance of the above fibers, with the exception of the *Boehmeria*, *Urtica*, and *Linum*, the derivatives giving in all cases the characteristic color-reaction with sodium sulphite.

Aniline Sulphate.—The solution of this substance, as also of the soluble aniline colors, is a valuable aid in diagnosing the fibers in regard to the distribution of the lignification, and also of incrusting substances. Neither the *Boehmeria*, *Urtica*, nor *Linum* gives any reaction; the *Ananassa* is colored a uniform faint greenish-yellow; the *Yucca* and *Agave* a pale gold; *Hibiscus* bright yellow and streaky; *Crotalaria* a pale yellow and streaky; and *Musa* a bright gold, also streaky.

Aniline Colors.—As is well known, the dyeing properties of the fibers vary with the lignification, and this appearing to be correlated with the development of phenols, we may hope to be able to arrive at a more correct understanding of this phenomenon.

In dyeing these fibers with a neutral solution of the so-called alkali blue, the effects appear to follow an inverse course, the *Boehmeria* showing the deepest color, the lignified fibers being much paler. This fact is probably referable to the presence of "pectous" substances in the former, and the reaction may prove to be of general use in indicating the presence of acids or acid-forming substances in the plant tissues.

In conclusion, I would note the grounds upon which the several determinations included in this method of diagnosis are based:

1. The yield of cellulose is of sufficiently obvious value, and an observation of its characteristics (2) is the qualitative supplement. The most important differences shown by the various celluloses are in relation to the solvent action of the alkalies upon them, and the degree of this action is usually shown by the condition of the cellulose fibers after washing and drying. The products of the action are in the first instance gelatinous, and those fibers which undergo degradation thereby, show an agglutination of the cellulose fibrils on drying. 3. The loss of weight sustained by boiling with an alkaline solution of arbitrary strength has been observed in two stages for the purpose of separating its more purely solvent action (continued for five minutes) from what may be termed its degrading action (continued one hour subsequently). These observations throw a certain light on the nature and order of stability of the bodies of which the fiber is composed; and attention will be drawn to this point in regard to the distinctive character of the jute fiber.

5. A high percentage of ash constituents is usually, in plant structures, associated with the presence or gummy or pectic substances; and the relatively small distribution of the latter throughout the wood and bast of plants accords with their low percentage of inorganic constituents. It is to be noted that the *Boehmeria* fiber stands conspicuously high in regard to its ash, and the presence of pectous substances thus indicated is confirmed by the large loss in weight sustained in the boiling alkaline solution.

6. Cellulose structures which differ from pure cellulose may be regarded as containing, in addition, (*a*) bodies of the pectic group; (*b*) substances connected with the trihydric phenols; (*c*) substances containing furfural—the union of these with cellulose being probably such as is known as combination by residues, *i. e.*, to form with the cellulose residue a chemical whole. The groups of compounds under *a*, *b*, and *c* differ from one another and from cellulose in respect of elementary composition, and its determination is a certain measure of the quantitative relations of these groups to one another. It may be remarked that *b* and *c* are in all cases yet observed coincidental, and agree also in respect of high carbon percentage: consequently, as factors in the mean carbon percentage of a fiber, they cannot as yet be separated.

7. The *chemical* evidence of lignification is the formation of substitution derivatives on exposure to the action of chlorine gas, and the proof of the formation of these is afforded by their characteristic color-reaction with solutions of the neutral sulphites.

To sum up these results and bring out more clearly the distinctive character of the jute fiber, I may recapitulate its more striking points of differentiation from the other fibers included in this investigation: 1. High carbon percentage. 2. Power of resisting the *continued* action of boiling alkaline solutions, from which, together with the results of an examination of the substances dissolved, it is to be inferred that the pure fiber contains no constituents of the pectic group. 3. Such uniformity in composition and properties as to permit us to regard it as a chemical whole. 4. Its comparatively simple microscopic features.

Some of these characteristics are represented among the other fibers, but are never united as in the case of jute, which is therefore to be preferred as a simple type of lignification; and over *biologically* complicated structures, such as wood, its superiority is still more manifest.

PNEUMONIA.*

By FRANCIS DELAFIELD, M.D., Professor of Pathology and Practical Medicine.

WE use the word pneumonia as a general term to designate the inflammations of the lungs. Anatomically there are four varieties of pneumonia—intra-alveolar pneumonia, interstitial pneumonia, the broncho-pneumonia of children, and tubercular pneumonia. You will observe that I do not use the words croupous and catarrhal pneumonia, and this is with design, for I believe that these terms are utterly inappropriate when applied to inflammation of the lung, and have led to much unnecessary confusion.

The most practical division of pneumonia, however, is according to the clinical groups in which the cases present themselves to us. We will, therefore, describe: The lobar pneumonia of adults; the secondary and complicating pneumonia of adults; the pneumonia of heart disease; the interstitial pneumonia of adults; the broncho-pneumonia of children; acute tuberculosis of the lungs; acute pulmonary phthisis; chronic pulmonary phthisis.

The Acute Lobar Pneumonia of Adults.—The inflammatory process regularly attacks at the very first a considerable portion of one or both lungs. The situation of the disease can be seen from the following figures given by Juergensen from an analysis of 6,666 cases: Right lung, 53·7 per cent.; upper lobe, 12·15; middle lobe, 1·77; lower lobe, 23·14; whole lung, 9·35. Left lung, 38·23; upper lobe, 6·96; lower lobe, 22·73; whole lung, 8·54. Both lungs, 8·07; both upper lobes, 1·09; both lower lobes, 3·34 per cent. In rare cases nearly the whole of both lungs will become inflamed at the very outset. The inflammatory process involves regularly the air vesicles, air passages, bronchi, interstitial connective tissue, and pulmonary pleura. It is customary to describe the inflammation as passing through four stages: congestion, red hepatization, gray hepatization, and resolution.

Congestion.—This stage usually escapes our observation for the reason that the patients do not die until later in the disease. The best example of the lesion that I have seen occurred in a woman, who died five hours after the initial chill. The right upper lobe was found firmer and more consistent than the rest of the lungs, but not hepatized. It was moderately congested and œdematous. The air vesicles contained a little granular matter, a little reticulated fibrine, a few pus cells, and a few epithelial cells, but not enough to fill the vesicles. There was a large number of white blood-globules in the capillary bloodvessels, and a swelling of the epithelial cells on the walls of the air vesicles. This first stage of congestion lasts but a few hours and is succeeded by

Red Hepatization.—The lung is now solid. Its cut surface, when fresh, is dry, granular, and red. The granules correspond to plugs of inflammatory matter which fill the air vesicles, air passages, and small bronchi. These plugs consist of pus cells, fibrine, epithelial cells, and red blood-globules. The air vesicles are not only filled, but distended by these inflammatory products, so that the inflamed portion of lung is voluminous and may compress the uninflamed portions. The interstitial connective tissue between the lobules of the lung is infiltrated with pus and fibrine; the pulmonary pleura is coated with fibrine. Of the fatal cases of pneumonia in which I have made autopsies, about one-fourth have died in the stage of red hepatization, and the duration of the disease in these cases has been from twenty-four hours to eleven days.

Gray Hepatization.—The lung remains of the same consistence, solid and unaerated, but its color changes. Portions gradually change from red to gray, so that the lung is first mottled red and gray, and then completely gray. The pulmonary pleura continues to be coated with fibrine; the small bronchi, air passages, and air vesicles are still filled with pus, fibrine, and epithelium, and the interstitial tissue is still infiltrated with fibrine and pus. The only changes are that the red globules have lost their coloring matter, the bloodvessels contain less blood, the products of inflammation commence to undergo granular and fatty degeneration. I have found that about one-half of the fatal cases die in the condition of mottled red and gray hepatization, and about one fourth in the condition of complete gray hepatization. The deaths with the mottled lungs occurred from the second to the eighteenth day; with the gray lungs from the fourth to the twenty-fifth day.

Resolution.—If the patients recover, the lung passes from the condition of gray hepatization into that of resolution. This stage of the inflammation usually escapes our observation, but occasionally patients die from accidental causes, and in this way I have seen a few examples of this condition. The lung is no longer completely solid or completely gray, but there is a mottling of solid gray and aerated red portions of lung. Some of the air vesicles are completely empty, some contain a little granular matter, some fatty epithelium and pus, some are still filled with the products of inflammation.

The lung may remain in the condition of gray hepatization for two or three weeks. It then becomes very white and dry, but there is no special change in the inflammatory products. I can see no reason for believing that this form of pneumonia ever passes into the condition of cheesy degeneration.

There are rare cases of lobar pneumonia in which fibrine is produced in unusually large amount; portions of lung tissue are compressed and become necrotic. In this way little cavities are formed containing fragments of dead lung tissue. Later the walls of these cavities are infiltrated with pus, so that abscesses are formed.

It is also possible for the inflammatory process to be characterized by an unusual production of pus, and even an infiltration of the walls of the air vesicles with pus. But I have never seen this condition reach such a degree as to form abscesses. The small bronchi are regularly filled with pus and fibrine, and in some cases the inflammation of the large bronchi becomes quite a feature of the disease. The inflammatory process may be catarrhal with a production of mucus, or croupous with the production of large cords of fibrine, which fill the bronchi. The pulmonary pleura is regularly coated with fibrine, but in some cases the pleurisy is developed to an unusual degree. Both pulmonary and costal pleura may be coated with a thick layer of fibrine and pus, and the pleural cavity may contain a considerable quantity of serum.

In rare cases lobar pneumonia is followed by gangrene of the lung. It is still unknown how this change is effected.

From what has been said it is evident that in lobar pneumonia we have an example of that form of inflammation in which the blood and bloodvessels take the principal share in the inflammatory process, while the tissue of the organ remains passive. The pus and fibrine are derived directly from the blood; it is only the new epithelial cells that are produced from the lung tissue. With few exceptions the blood continues to circulate through all the vessels of the lung, so that no part of the organ loses its vitality. When the inflammatory process, therefore, has run its course and the products have been absorbed, the lung is left unchanged in its structure.

Etiology.—Lobar pneumonia occurs in nearly all climates, warm as well as cold. In the United States it is even more prevalent in the Southern States than in the Northern. To ascertain the prevalence of the disease in New York city, I have examined the records of the Board of Health for a period of four years, beginning on March 1, 1871. These records give all the fatal cases of pneumonia occurring during that period. After excluding all the secondary and complicating pneumonias, the whole number of fatal cases for the four years was 7,873. Of these 3,623 were in children under five years old. In persons over five years old the great majority of deaths occurred in March, April, May, November, December, January, and February. January showed the largest number of cases, then February, April, May, and March in order. Comparing the mortality with the daily temperature and the daily range of temperature, it was found that the number of cases of pneumonia increased regularly with the lowness of the temperature and the extent of its daily range.

There can be no question that in a moderate number of cases of pneumonia the disease is developed within a few hours after exposure to cold and wet, but in many other cases no such exposure can be discovered. There is a difference in different years and in different places as to the frequency and mortality of the disease. Occasionally local epidemics occur in a single building or a single town.

Considerable attention has been directed lately to the question of the character of pneumonia, whether it is a general disease with a characteristic local lesion or a local lesion attended with constitutional symptoms. It is not necessary for me to lay before you the reasons for these two opinions. It is sufficient to say that the prevailing opinion is that pneumonia is a general disease, while I am still of the belief that it is a local inflammation.

As a rule, children under five years old have broncho-pneumonia; persons between five and fifteen years of age may have either lobar pneumonia or broncho-pneumonia; persons over fifteen years old have lobar pneumonia.

Physical Signs.—In the stage of *congestion* the regular signs are moderate dullness and a subcrepitant rale. As soon as there is pleurisy a crepitant rale is developed.

While in the condition of *red and gray hepatization*, the inflamed lung gives dullness on percussion, increased vocal fremitus, bronchial voice and breathing.

In the stage of *resolution* the dullness and the vocal fremitus decrease, the bronchial voice and breathing become less and less marked; crepitant, subcrepitant, and coarse rales are heard.

In the stage of congestion there may be no dullness nor rales, nothing but a change in the breathing. The respiratory murmur may be feeble, or harsh and exaggerated. Occasionally a bronchitis of the larger tubes is developed at the outset of the disease, and then we hear coarse rales all over both lungs.

In the stages of red and gray hepatization the percussion note, instead of being dull, may be flat, tympanitic, amphoric, or cracked pot. Vocal fremitus, instead of being increased, may be decreased. There may be neither bronchial voice nor breathing.

In the stage of resolution, dullness, crepitant rales, and feeble breathing may persist for an unusual length of time.

All the physical signs are apt to be obscure in old persons, and may even be absent altogether.

Rational Symptoms.—The invasion of the disease is in about one-fourth of the cases preceded by an irregular fever with moderate prostration, lasting from one to four days. In the rest of the cases the invasion is sudden. One or more rigors of greater or less severity are the first symptoms of the disease in most cases. (Lebert 92 per cent., Grisolle 80 per cent.) It is customary to reckon the duration of the disease from the time of the initial chill. The temperature rises at once, and usually reaches its maximum by the second or third day. After this it is a continuous fever, with evening exacerbations, until defervescence takes place. Defervescence may take place at any time from the second to the eighteenth day, but in more than half the cases it occurs on the seventh, fifth, eighth, or sixth days (Juergensen). The fever usually begins to subside in the evening, and requires from six to forty-eight hours for its disappearance. After defervescence the temperature may fall for a few hours below the normal. A temperature of from 99° to 104° F. may be called the normal temperature of lobar pneumonia in adults. Higher temperatures indicate abnormal forms of the disease. If the inflammation extends and involves other parts of the lungs, then the fever is protracted, or returns again after defervescence. In exceptional fatal cases the temperature is below the normal for two or three days before death. Sweating accompanies the fever in a considerable number of the cases. It is often profuse and persistent. In other cases, however, the skin is always hot and dry. Pain is regularly developed within twelve hours after the chill. It is sometimes slight, sometimes severe, sometimes absent. It is referred to the affected side, usually to the region of the nipple. This pain is apparently due to the associated pleurisy. The pulse should be somewhat increased in frequency and of fair strength—about 100. A feeble pulse of over 120 should always excite apprehension, even if the patient is apparently doing well. Slow pulses of 60 to 70 are met with in exceptional cases. The respiration at once becomes rapid, rising to 30 or 50. Not only is the breathing rapid, but it may be labored, especially during the first twenty-four hours of the disease. In some cases the oppression and dyspnœa are at this time very urgent, so much so that the patient feels that he will die unless immediate relief is afforded. Cough is developed within a few hours, moderate in some cases, harassing in others, often absent in old people. With the cough is an expectoration, at first white and mucous, later mixed with blood and pus so as to have a yellowish or reddish color. The sputa regularly consist of two parts, a thin watery fluid and little rounded pellets of more consistent and tenacious mucus. In bad cases the whole sputa may be thin and dark-colored, like prune juice. I have seen in one case an hæmoptysis of about three teaspoonfuls of pure blood at the outset of a lobar pneumonia. Cases with nothing but white mucous sputa are not uncommon; and in old persons there is often no expectoration at all. The cheeks are usually flushed. The tongue is coated with a white fur, and in severe cases becomes dry and brown. The appetite is lost, and vomiting may be repeated several times at the beginning of the disease. The urine is diminished in amount, high-colored, and occasionally contains albumen and casts. Cerebral symptoms are present in greater or less degree in most of the cases. A peculiar irritability and restlessness with inability to sleep are very common symptoms. In more severe cases headache, delirium, stupor, and coma are also present. Such cerebral symptoms are especially marked in alcoholic patients, in old persons, and pneumonia of the upper lobes.

Complications.—Pleurisy with a considerable exudation of serum complicates about 12 per cent. of the cases (Grisolle). It is apt to persist after the resolution of the pneumonia. If it is a purulent pleurisy, the patients usually die. Pericarditis, usually with the production of fibrine without much serum, complicates some cases, especially if both lungs are inflamed. In some cases the only evidence of such a pericarditis is the fact that the patient seems more seriously ill. In other cases the pericardial friction sound is heard, the pulse becomes more rapid and feeble, the blood accumulates in the veins, the breathing is more rapid and labored. Meningitis may be developed sometimes without symptoms, sometimes with severe headache, greater restlessness, delirium, contraction of the voluntary muscles, stupor, and coma. Jaundice is observed in a moderate number of cases. It may complicate mild examples of pneumonia without apparently adding anything to the patient's symptoms; or it may appear in the course of a more severe pneumonia and be attended with more marked cerebral symptoms. The kidneys may become the seat of a moderate degree of parenchymatous nephritis, or they may have been in the condition of chronic diffuse nephritis before the pneumonia attack. In the latter case there may be general convulsions.

The Course of the Disease.—In regular cases, after a few hours or days of irregular fever and prostration, or without any premonitory symptoms, the patient is seized with one or more rigors, followed by a febrile movement. He at once feels seriously ill, may vomit, and complains of oppression and difficulty of breathing. The next day, after a restless night, the patient lies in bed with flushed face, a hot, dry skin, a tongue coated with white, rapid breathing, a temperature of 100° to 103°, a pulse of about 100, and full; there is pain in the affected side of greater or less severity, cough with mucous expectoration, and the physical signs of congestion, or of red hepatization. All these symptoms continue; the temperature from 100° to 104°; the pulse 90 to 100; the breathing 25 to 40. The physical signs are those of red and gray hepatization. The sputa have the color and shape characteristic of the disease. On about the seventh day of the disease defervescence takes place. The temperature falls to the normal, or below it; the pulse and breathing become less rapid; the tongue begins to clean off; the restlessness disappears; and the patient feels quiet and comfortable. The physical signs of resolution continue for a few days, then disappear, and the patient is fairly convalescent.

Cerebral Cases.—In patients addicted to the use of alcohol, in old people, and in cases of pneumonia of the upper lobes, cerebral symptoms are especially marked. Professional and business men are more likely to have cerebral symptoms than are mechanics and laborers. In many of these cases the extent of lung inflamed is small in proportion to the severity of the symptoms. Besides the restlessness, sleeplessness, headache, stupor, delirium, and coma which characterize these cases, there are usually a high temperature, a rapid and feeble pulse, and a dry tongue. Delirium and stupor may persist for several days after defervescence.

In irregular cases the physical signs of consolidation may be slow in appearing. You may examine a patient's chest day after day and find no evidence of solidification of the lung. The longest delay of this kind which I have seen was for eight days. Resolution may be delayed for two or three weeks after defervescence, with persistence of the physical signs of consolidation.

The Pneumonia of Old People.—In people over seventy years old the disease is apt to run an irregular course. The chill, the pain, the cough, the sputa, and the physical signs may all be absent. Fever, cerebral symptoms, a rapid and feeble pulse, rapid breathing, and marked prostration may be the only symptoms. I have seen such an irregular course of the disease in persons not over fifty years old. There are also curious cases reported of pneumonia in old persons, who only seem feeble but are not confined to bed. They present no symptoms to excite suspicion until they suddenly die, and the pneumonia is discovered at the autopsy.

Typhoid Pneumonia occurs usually in epidemics. The cases are characterized by the severity of the constitutional symptoms and the rapid prostration.

Complicated Cases.—Meningitis, pericarditis, pleurisy with effusion, cardiac disease, and chronic renal disease all may alter the regular course of the disease in ways which have been already described.

The Fatal Cases of Pneumonia.—Pneumonia seems to prove fatal in several different ways. There are cases in which death seems to be directly due to the large area of lung tissue which is infiltrated with inflammatory products and rendered incapable of performing its natural functions. There are cases in which only a part of one lobe is affected, and yet the constitutional symptoms are very marked and seem to destroy life by their severity. Death is due to one of the complicating lesions: meningitis, pleurisy, pericarditis, cardiac disease, chronic renal disease. A certain number of cases of lobar pneumonia die suddenly. In some this sudden death seems to be due to interference with respiration. The patients are suddenly attacked with rapid and difficult breathing and die in from half an hour to a few hours. In these cases we often find after death congestion and œdema of the uninflamed portions of lung. Other

* A lecture delivered at the College of Physicians and Surgeons, New York.—*Lancet.*

cases seem to die from failure of the heart's action. In severe pneumonia the heart's action is often rapid and feeble, and it may at any time become so feeble that death takes place suddenly. But even in comparatively mild cases of the disease death may take place in the same way. The disease will run its ordinary course for several days, often for a week, then the heart will suddenly begin to act very feebly, the skin becomes cold, the patient passes into a sort of collapse and dies, sometimes in a few minutes, sometimes after several hours. In rare cases death may take place during convalescence, from thrombosis of the coronary arteries.

Duration.—The constitutional symptoms last until defervescence takes place—that is, from the second to the eighteenth day. Resolution follows at any time from two to twenty days later. The fatal cases may die at any time from five hours to three weeks after the initial chill. In New York most of the adults die on the seventh, eighth, and tenth days; most of the persons over seventy on the fifth, sixth, and seventh days.

Prognosis.—The prognosis depends on the extent of lung involved in the inflammatory process; on the existence of complications; on the age of the patient (persons over seventy years of age seldom recover); on the social condition of the patient. Laborers and mechanics are more apt to recover than professional and business men. The prognosis is always much worse in patients addicted to the use of alcohol.

Treatment.—The treatment of lobar pneumonia calls for the exercise of much knowledge and judgment on the part of the physician. It is necessary to be practically acquainted with the course of the disease, and to appreciate fully the exact condition of each patient. There is no routine treatment for pneumonia; each case must be managed on its own merits. If we see a patient during the first twelve hours of a pneumonia, the question presents itself as to whether we shall try to abort the disease. This may be done in two ways: by general bloodletting, or by large doses of calomel. The latter plan is the one more frequently employed in New York. From twelve to twenty grains of calomel are placed on the patient's tongue, and this dose may be repeated in six hours. In favorable cases either the bloodletting or the calomel may cause defervescence to take place within a few hours. But both these plans fail in more cases than they succeed. Ordinarily no such attempt is made to abort the disease. Our first care is to put the patient into a condition of absolute rest. He is to be kept in bed, fed on fluid food, and given opium in small doses. Everything which can annoy or irritate the patient is to be strictly avoided. If the temperature runs between 100° and 104°, it requires no treatment. If it rises higher than this, we may sponge the skin with alcohol and water, give diaphoretics, and aconite or veratrum viride in small doses. Large doses of quinine, cold baths, and cold affusions not only make no permanent reduction in the temperature, but they are positively dangerous. The pulse should regularly be between 100 and 120. If it is above 120 and feeble, we should endeavor to render the heart's action slower and stronger. The most efficient agent for this purpose is alcohol. Either wines, whisky, or brandy can be perscribed. The amount of alcohol used is to be regulated by its effect on the pulse. It is often well to combine with it either opium or the liquid extract of convallaria. This seems to be the only indication for the use of alcohol in lobar pneumonia. Unless it is required as a cardiac stimulant, the patient is better without it. If the breathing is not only rapid but oppressed at the onset of the disease, the patient may often be relieved by the use of wet cups, dry cups, warm fomentations, or mustard plasters over the whole of the chest. If such oppression continues through the disease, it may be mitigated by the use of calomel and opium in small doses, by aconite and veratrum viride, and by diaphoretics. For the pain in the side, the restlessness, and the sleeplessness, the most efficient remedy is opium, selecting the preparation and the dose to suit each patient.

From what has been said, you will infer that many cases of pneumonia require no treatment but rest and opium; and this is true. If the disease is running a mild and regular course, you are not likely to improve matters by interference. The only indications for treatment are to relieve an abnormal development of any of the symptoms which may threaten to disturb the patient.

BEE CULTURE IN INDIA.

THE following information respecting the bee industry in India is gathered partly from the *Indian Agriculturist*. The details were obtained by Mr. John Douglas, Superintendent of Telegraphs, from Mr. Morgan, Deputy Conservator of Forests, and are noteworthy from the light they throw on the modes of collecting wild honey. The best honey-producing flower of Southern India is the strobilanthes, which not only forms the principal undergrowth of the *sholas*, both temperate and tropical, but spreads over the grassy slopes of the higher elevations. There are an immense number of species in this genus, and they almost all flower once in seven years, dying down entirely, and afterward a fresh growth springing up from seed. Whenever any species of strobilanthes flowers, colonies of bees migrate from all parts of the country to feast on the honey, and rear their young broods. At such times honey becomes plentiful and cheap, and as the strobilanthes honey is of the finest quality and flavor, even rivaling that from the famous Mount Hymettus, it is eagerly sought after by the Todas of the Neilgherry Hills, and in fact by all aboriginal tribes. The year 1879 was such a season for honey that it sold at the rate of 4 annas per imperial pint, whereas its usual price is from 8 to 10 annas. This honey, in the cold climate of the Neilgherries, crystallizes in from a fortnight to three weeks, when the flavor becomes richer and finer. In the Wynaad, as soon as the moon has waned sufficiently, great preparations are made to take the honey. Bamboo and rattan ladders are constructed, sometimes of astonishing length, and at nightfall, after 9 P.M. —for the bees do not go to bed till then, as you will find to your cost if you disturb them—the Jain (honey) Kurumbars proceed to the *burray*, and, having erected their ladders, if they have to climb upward, or suspended their cane ladders, if downward, arm themselves with torches and knives and sever the combs from the rock or branch. The drowsy bees, meanwhile, roused by the glare of the torches, desert the combs, and buzz aimlessly about, even on the persons of those engaged in taking the combs, but never attempt to sting, unless crushed or hurt. The combs are then lowered down in baskets, the Kurumbars feasting on the larvæ, which taste something like cream, while the fish, which swarm in thousands when the hives are built over a river, have a glorious feed on the grubs and bees that fall into the water and float helplessly down stream.

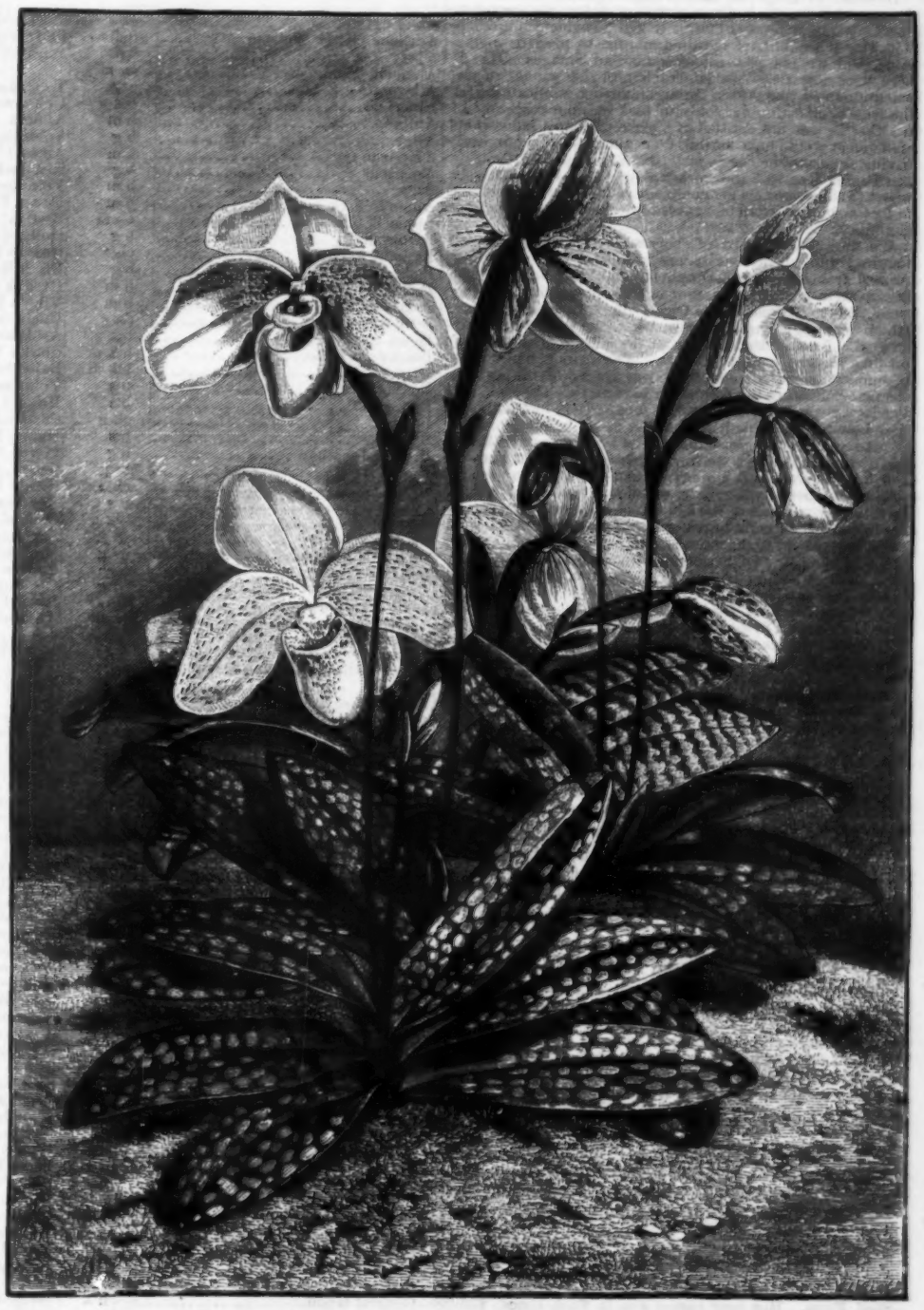
The Coorgs make some attempts at bee culture and practice the industry to a small extent in their own homes; the bees are domesticated, and the hives, which are of a very primitive description, made merely of the hollowed out trunks of trees, are placed near the houses. The Coorgs have, however, no notion of collecting the surplus honey by any of the contrivances, such as bell glasses, supers, etc., in use in England in the different apiaries.

In Cuddapah wild honey is collected also from the cliffs and ravines of the district. The process adopted is both perilous and exciting, and the Yanadies alone are able to climb into the difficult and apparently inaccessible places over perpendicular cliffs, in some places from 100 to 200 feet in height. They do this by the aid of a plaited rope, made of young bamboos tied together. This rope sometimes gives way, the result being a terrible accident. It is a very nervous sight to watch the men climbing up these frail supports, and it reminds one of the egg collecting process in northern latitudes. The men, from below, look like little babies hanging midway, the rope being fastened on the top of the cliff above by means of a peg driven into the ground, or to the trunk of a tree, the man swinging midway with 100 feet or so above and below him, and armed with a stick and a leather basket. The Yanady first burns some grass or brushwood under the hive, by which the bees are driven out; he then swings the rope until it brings him close to the hive, which he pokes with his stick, holding out his basket at the same time to catch the detached portions of comb. When the basket is full he shakes the rope, at which signal his comrades above draw him up. The bamboo ropes are left to hang, often for years, until they rot away, for a rope of this kind is never used twice, a fresh one being made on each occasion and at each place.

South Canara is also a great honey district. The honey and wax have, however, but little local value, a maund, about 25 lb. only fetching R2 and R16. It is thought that much might be done to open up the industry by exporting the honey and wax to England, the latter being a valuable product and one for which there is always a demand. The trade at present in Indian honey is almost entirely confined to wild honey; but as the keeping of bees is an industry requiring little or no capital, it is especially adapted to the people of India. Should the returns obtained from the inquires now made and set on foot by Mr. Douglas show that it is worth while to introduce this industry in a practical form, then Mr. Buck—the whole subject having been placed under his department—may possibly see his way to making a decided effort to interest the people in systematic bee culture with a view to the trade in honey and wax becoming ultimately a profitable one to the country—*London Times*.

CYPRIPEDIUM SEDENI ×.

MR. KESTERTON sends us a flower of this plant, which possesses considerable structural interest. It will be remembered that orchids generally have but one stamen placed opposite to the lip, at, or near, the top of the column. That one stamen is considered to be the sole existing perfect member of a row of three outer stamens, of the existence of which, actually at one period—potentially now, there is abundant and varied evidence, also of another row of three stamens internal to the first. These six stamens, or their traces, are more or less clearly recognizable in the "column." In Cypripedium there are ordinarily two stamens, one on each side of the column, the presumption being that these two are members of the inner whorl of stamens. In the flower sent by Mr. Kesterton, one sepal (the upper) is absent, its place being supplied by one of the lateral petals twisted out of place, the other lateral petal being absent. The two lateral sepals are united together as usual. The lip is perfect. The column bears, springing from its back, opposite the single petal, a filament with a two-celled anther. The inference of course is, that this stamen corresponds to that which is commonly developed in other orchids, and that, therefore, this particular Cypripedium flower has in so far assumed the characteristics of an orchid proper. Now arises the question, whether the orchid type or the Cypripedium type is the older? Did the orchids precede the Cypripediums, or were the Cypripediums offshoots from the orchids proper? If the orchid type be the older, then this Kestertonian Cypripedium may be regarded as taking a retrograde step in reverting to the ancestral condition of its race. If, on the other hand, Cypripediums preceded other orchids, then this particular Cypripedium has been caught in the act of evolving itself into an orchid. This is a knotty point for those who are fond of speculating about pedigrees in plants to discuss. For our own part we do not think there is sufficient evidence either way at present, though we would not discourage speculation so long as it is based on facts and not made the subject of dogmatic assertion. It is singular that exactly the same malformation was recorded by Mr. Le Marchant Moore in the



CYPRIPEDIUM NIVEUM AND C. CONCOLOR.

Journal of Botany some months ago in a plant of the same kind growing at Kew. The hybrid origin of the plant is also a point to be remembered. Were the history of the plant not known, it might have been supposed that *C. edeni* was the issue of a cross between an orchid and a Cypripedium.—*Gardeners' Chronicle.*

[THE SPIRIT OF THE TIMES.]

TROTTING STATISTICS.

WE publish this week a table of trotting statistics which are of a character different from anything ever before compiled. It is designed to group, in alphabetical order, the trotters that have been most successful in winning money, for, after all is said and done, there is no such stimulus to breeding speed as the hope of making it remunerative. Even the select few, who would breed and train for the pure love of the business, take pride in pointing to the list of rich prizes won by their favorites, as being the surest tokens of merit, although their souls may be above the attractions of filthy lucre.

In order to keep this table within bounds, the line was drawn at horses who had won purses or stakes, the aggregate of which was at least $10,000. It will be evident, on reflection, that it would have required months to prepare such a table, had we not possessed peculiar advantages. Had it been necessary to investigate each probable winner of the amount named, and search through existing publications for the sum of his winnings, only to find in nine cases out of ten that he was not entitled to a place, the most industrious statistician would have shrunk from the task. In our case, having access to the sheets of "Chester's Complete Trotting and Pacing Record," the work was rendered comparatively easy. There were few instances where it was even necessary to foot a short column of figures to decide as to the horse's eligibility.

We find that this list of "big winners" comprises two hundred and twenty-one names of horses that have performed from the days of Dutchman and Lady Suffolk, who began their victorious careers in 1838, down to the Clingstone, Edwin Thorne, Santa Claus, etc., of the present day, whose winning figures promise yet to be considerably increased. None of the columns of the table is of more interest than the one headed "Career." The years given, it must be understood, refer to the victorious career of the animal, the first indicating the date when his first race was won, and the last when his last race was won. It is instructive to note how brief a time it is, in many cases, before the victor of one year is cast into the shade by the new rivals that spring up. It has been shown, in several cases, that a trotter can bear active campaigning for ten, or twelve, or even a greater number of years, yet we find that one hundred and four, nearly one-half of the $10,000 horses, were not successful in races for a period greater than five years. As a rule, we think, the old-time trotter stayed longer at the front than those of the past two decades, but that fact may be attributable to there having been less competition, and they were not so soon outclassed. A striking exception to this is found in the veteran Tom Keeler. Under the name of Cayuga Chief he won his first race in 1867, at Clyde, N. Y., and his thirty-seventh was won in Maine, in 1883. This is a period of sixteen years, and none of the intervening calendar divisions has failed to see him at the front one or more times, except 1868 and 1881. He is a marvel of wear. Old Lady Suffolk is only one season behind him, and she won a much greater number of races, seventy-five being credited to her, more than twice Tom Keeler's quota. Chicago, alias Hardbread, alias Jim Rockey, outranks even Tom Keeler, having won his first race in 1859, and his last in 1876, no less than eighteen seasons of hard campaigning. We believe he is still alive in California. An interesting reminiscence of him was recently published, and, if we are not mistaken, he won a scrub race last year. Other notable "lasters" are: Brother Jonathan, Byron, Confidence, Cozette, Derby, Ethan Allen, Flora Temple, George Wilkes, Goldsmith Maid, Hotspur, Huntress, John H., John Stewart, Lady Franklin, Lady Moscow, Lady Star, Pilot Temple, Silas Rich, and Thomas Jefferson, all of whom have a successful career of at least ten seasons' duration.

The palm as a campaigner must be awarded to Goldsmith Maid. From 1866 to 1877 this marvelous little mare had one hundred and twenty-one victories, and the eighty-six of Flora Temple are the nearest approach to her in this respect. The number of heats that she trotted in 2:30 or better was three hundred and thirty-two, as counted by those who keep track of such matters, and the amount of the purses and stakes in the contests for which she was victress was the enormous sum of $364,200, more than treble the amount credited to any other performer. This, of course, by no means represents net winnings. As a rule, of late years, the winner of a trotting purse has netted four-tenths of its amount, but in the case of Goldsmith Maid her average was much greater than this. In her case, as it is a matter of curiosity, we have figured the actual net gains, aside from expenses, that she has brought to her owner, and they foot up $246,750. The greatest winner on the running turf in this country was Hindoo, and his net earnings amounted to less than $90,000. No horse of any age or country ever won so much money as the little inbred Abdallah mare, who is now meekly performing the duties of a matron at Fashion Stud Farm. Her long career was in flush times, $10,000 purses were not infrequent, and several people whom she has enriched have cause to bless the day when it was decided that she was too ill-tempered for plowing, and had better be trained for the track. There are but three others whose winnings reach treble figures in the thousands, viz., American Girl, $118,100; Rarus, $114,950; and Judge Fullerton, $102,035. Dexter, Flora Temple, Hopeful, and Lady Thorn do not fall far short of reaching $100,000.

The educated constituency that we address will not fail to draw encouragement from the table of "Big Winners." It shows what is possible with good care and a reasonable measure of success. They will recall, as they peruse these names, the history of the horses, will note their breeding, and remember, to a great extent, how their campaigns were conducted. They will bear in mind that a winning of, say, $10,000 from 1876 to 1883 is equal to at least $20,000 from 1870 to 1876, because purses have been so much decreased in size of late years, and they will also not fail to note the admirable manner in which some trotters have been handled to secure the measure of success which entitles them to a place in this table. It is very little for a Princess to win $49,500 when $36,500 of it was the result of one match against a horse whom she far excelled in speed, but it requires the best of management to bring the winnings of a horse like St. James up to nearly an equal amount, or to win over $35,000 with a horse like old Tom Keeler, who never went in first-class company.

As an illustration of the fact that speed brings the money, we miss but few horses that have beaten 2:20 from the $10,000 lists. The absentees are: Hattie Woodward, 2:15½; Jerome Eddy, 2:16¼; So So, 2:17¼; Edwin Forrest, 2:18; Kate Sprague, 2:18; Fanny Witherspoon, 2:18¼; Pickard, 2:18¼; Col. Lewis, 2:18½; J. B. Thomas, 2:18¾; Cleora, 2:18¾; Patchen, 2:18¾; Adele Gould, 2:19; Edward, 2:19; Graves, 2:19; Jay Eye See, 2:19; Kitty Bates, 2:19; Minnie R., 2:19; Croxie, 2:19¼; Keene Jim, 2:19¼; Romero, 2:19¼; Thomas L. Young, 2:19¼; Troubadour, 2:19½; Von Arnim, 2:19½; Dalsydale, 2:19¾; Dr. Norman, 2:19¾; John S. Clark, 2:19¾; Josephus, 2:19¾. This list may seem long, but it is only twenty-seven out of a total of eighty-two.

This table also furnishes a new test of the success of stallions. Tried by it, we find that Volunteer heads the list, with ten representatives, while his sire, Rysdyk's Hambletonian, ranks second, with eight of his get in the table. The only other stallions that have more than two representatives, are: Ethan Allen, 3; Daniel Lambert, 3; Young Columbus, 4; Blue Bull, 4; Vermont Black Hawk, 3; Alexander's Abdallah, 3; and Edward Everett, 3. There is much food for study in the table.

[FROM THE SPIRIT OF THE TIMES.]

THE BIG WINNERS.

ALPHABETICAL list of trotters who have won races in which the purses, stakes, or premiums aggregated $10,000 and upward, to the close of 1882, with description, sire, date of career, best record, number of races won, and amount of purses won.

NAME.	DES.	SIRE.	CAREER.	WON.	RECORD.	AMOUNT.
Abe Edginton	gr g	Stockbridge Chief, Jr	1875 to 1878	4	2.23¼	$22,400
Adelaide (Kitty Watson)	b m	Phil Sheridan	1874 to 1879	20	2.19¾	28,800
Ajax	b s	Whipple's Hambletonian	1869 to 1876	9	2.29	24,150
Alameda Maid	ch m	" "	1870 to 1877	9	2.27½	10,550
Albemarle	gr g	Tom Hunter	1876 to 1878	8	2.19	10,900
Albert	blk g	Unknown	1873 to 1875	8	2.24¾	10,450
Aldine	b m	Almont	1876 to 1882	11	2.19¼	14,100
Alley	b g	Volunteer	1875 to 1882	24	2.19	21,050
American Girl	b m	Amos' C. M. Clay	1868 to 1875	49	2.16½	118,100
Americus	b g	Red Jacket	1841 to 1846	11	2.33¼	11,700
Amy	b m	Volunteer	1875 to 1879	8	2.20¼	12,200
Annie Collins	b m	Edwin Forrest	1871 to 1876	25	2.23½	17,050
Annie W	ch m	Bostick' Almont, Jr.	1880 to 1882	21	2.20	12,825
Barney Kelly	b g	Holland's Ethan Allen	1872 to 1878	28	2.25	12,300
Bashaw, Jr.	ch s	Green's Bashaw	1866 to 1870	20	2.24¾	21,600
Bateman	b g	Black Harry Clay	1875 to 1879	19	2.22	13,300
Bella (Maud)	b m	Rysdyk's Hambletonian	1874 to 1876	12	2.22	18,250
Belle Brasfield	b m	Viley's Cripple	1873 to 1881	20	2.20	13 200
Billy Barr (W. B. Whitman)	dn g	Ethan Allen	1867 to 1874	10	2.23¾	12,850
Black Cloud	blk s	Ashland Chief	1879 to 1882	17	2.17¼	12,685
Blackstone Belle	blk m	Clark's Whalebone	1864 to 1867	10	2.28½	19,450
Blanche	blk m	Railsplitter	1872 to 1875	14	2.23½	15,400
Bodine	b g	Volunteer	1870 to 1877	27	2.19¼	47,970
Bonesetter	b s	Brook's Horse	1878 to 1881	30	2.19	32,950
Bonner	ch g	Cortland Star	1874 to 1875	12	2.23	12,500
Brigadier	b s	Happy Medium	1877 to 1882	23	2.22	19,100
Brother Jonathan	b g	Potter Horse	1871 to 1880	18	2.24	11,750
Brown Dick	br g	Son of American Star	1856 to 1864	16	2.25¼	11,450
Byron	ch s	Field's Royal George	1867 to 1877	25	2.25½	11,300
Calmar	b g	Bourbon Chief	1876 to 1881	19	2.22	10,400
Camors	blk g	General Knox	1873 to 1874	8	2.19¾	14,250
Capt. Magowan	rn g	Sovereign	1860 to 1866	4	2.49½	15,050
Charley Ford	gr g	McKesson's Gray Eagle	1877 to 1881	38	2.16¾	42,350
Charley Green	b g	Careless	1870 to 1878	17	2.26¾	17,300
Chicago (Hardbr'd and Jim Rockey)	br g	Ole Bull	1859 to 1876	38	2.24¾	21,250
Clara (Crazy Jane)	b m	Sager Horse	1865 to 1871	29	2.27	10,875
Clementine	br m	Addison, Jr.	1873 to 1875	13	2.21	35,500
Clifton Boy	blk g	Joe	1874 to 1879	24	2.23	11,550
Clingstone	b g	Rysdyk	1881 to 1882	10	2.14	19 000
Clover (Brightwood and Dalon)	b g	Young Hindoo	1874 to 1882	38	2.25¼	14,460
Comee	b g	Daniel Lambert	1873 to 1877	25	2.19¾	28,600
Commodore	b g	Young Post Boy	1872 to 1879	12	2.23	11 050
Commodore Vanderbilt	b s	Young Columbus	1864 to 1867	11	2.25	18,650
Confidence	b g	Sir Henry	1833 to 1842	8	2 35	10,350
Cooley	blk g	Daniel Boone	1864 to 1866	10	2.26	13,000
Cozette	blk m	Blumberg's Black Bashaw	1870 to 1879	25	2.19	34,550
Crown Prince	wh g	Logan's Messenger	1871 to 1873	13	2.25	22,550
Darby (John Murphy, Jr)	br g	Delmonico	1876 to 1880	33	2.16½	43,680
Deception	gr g	Unknown	1875 to 1879	34	2.22½	12,275
Deck Wright	b g	Hinsdale Horse	1877 to 1882	24	2.19¾	12,400
Derby (Dutchman and Alvin B.)	b g	Rough and Ready	1867 to 1877	12	2.25½	10,035
Dexter	b g	Rysdyk's Hambletonian	1864 to 1867	49	2.17¼	86,500
Dick Swiveller	b g	Walkill Chief	1876 to 1879	14	2.18	24,100
Doctor Lewis (Flexible)	ch g	Marshall Chief	1873 to 1878	37	2 24	16,435
Driver	b g	Volunteer	1876 to 1882	48	2.19½	44,950
Dutchman	b g	Tippoo Saib	1838 to 1843	15	2.32	12,450
Edwin Thorne	ch g	Thornedale	1880 to 1882	23	2.16½	38,450
Ella Lewis	b m	Vermont	1873 to 1879	6	2.27	11,850
Elmo (St. Elmo)	ch s	Mohawk	1870 to 1873	8	2.27	15,500
Elsie Good	ch m	Blue Bull	1876 to 1880	13	2.22½	10,450
Emma B.	gr m	Bayard	1878 to 1881	18	2.22	12,000
Empress	b m	Unknown	1864 to 1871	23	2.30	13,250
Ethan Allen	b s	Vermont Black Hawk	1853 to 1866	19	2.25½	15,500
Fanny Allen	b m	Ethan Allen	1865 to 1870	18	2.28¼	13,025
Fanny Fern	ch m	Unknown	1869 to 1873	16	2.32¼	10,700
Fearnaught	ch s	Young Morrill	1865 to 1868	6	2.23¼	19,450
Fleety Golddust	gr m	Golddust	1872 to 1874	7	2.20	14,100
Flora Belle	b m	Steven's Uwharrie	1870 to 1872	8	2.22¾	18,325
Flora Temple	b m	Bogus Hunter	1852 to 1861	86	2.19¾	92,900
Foxie V	ch m	King Herod	1877 to 1882	24	2.26	10,150
France's Alexander	blk s	Ben Patchen	1880 to 1882	9	2.19	15,600
Frank J. (Milton Day)	dn g	Unknown	1874 to 1875	14	2.23¾	12,650
Frank Munson	ch g	Paragon	1874 to 1880	26	2.25	12,450
Frank Palmer	br g	Unknown	1871 to 1876	25	2.26¼	13,475
Fred Hooper (J. Ellis)	b g	Royal George	1873 to 1878	18	2.23	41,225
Gazelle	b m	Rysdyk's Hambletonian	1872 to 1878	6	2 21	13,250
General Butler	blk g	Smith Burr	1861 to 1868	30	2.23¼	40,100
General Grant	ch s	Wapsie	1872 to 1876	16	2.21	17 935
General Howard (Country Boy)	br g	Badger Boy	1869 to 1877	18	2.26½	11,350
General McClellan	dn g	Montauk	1862 to 1870	17	2.29	12,450
George M. Patchen	b s	Cassius M. Clay	1859 to 1863	18	2.23¼	33,650
George Palmer	br g	Palmer Bogus	1867 to 1872	16	2.29¾	16,650
George Wilkes (Robert Fillingham)	br s	Rysdyk's Hambletonian	1861 to 1872	27	2.22	50,150
Gloster	b g	Volunteer	1872 to 1874	18	2.17	54,200
Goldsmith Maid	b m	Alexander's Abdallah	1866 to 1877	21	2.14	364,200
Grafton	ch g	Van Meter's Waxy	1874 to 1875	16	2.22¼	10,400
Granville	ch g	American Clay	1874 to 1879	19	2.26	13,750
Gray Eagle (Gray Jim)	gr s	Papineau	1864 to 1870	—	2:31	10,275
Gray Eddy	gr g	Morse Horse	1854 to ——	5	2.28½	10,500
Great Eastern	b g	Walkill Chief	1875 to 1878	10	2.18	10,800
Hannah D.	b m	Magna Charta	1874 to 1878	28	2.22¼	20,225
Hannis	ch s	Mambrino Pilot	1877 to 1880	21	2.17¾	29,050
Harry Harley (Columbian Chief)	b g	Young Columbus	1868 to 1871	4	2.25¾	36,950
Harvest Queen	b m	Rysdyk's Hambletonian	1869 to 1871	4	2.30	21,000
Helene	ch m	Hambletonian Prince	1880 to 1882	15	2.21	11,200
Henry	b g	Harry Lathrop	1869 to 1871	13	2.20¼	23,250
Honest Harry	rn g	Winthrop Morrill	1874 to 1879	14	2.22½	10,580
Hopeful	gr g	Godfrey's Patchen	1873 to 1881	49	2.14¾	86,400
Hotspur (Col. Maynard)	b g	Ethan Allen	1867 to 1879	27	2.24	35,560
Huntress	b m	Volunteer	1871 to 1880	25	2.20¾	24,950
Idol	ch m	Black Warrior	1867 to 1872	16	2.27½	16,775
Irene	gr m	Dusty Miller	1876 to 1881	10	2.20¼	11,100
Jack Draper	gr g	Humbird	1869 to 1877	26	2.27	15,835
Jay Gould (Judge Brigham)	b s	Rysdyk's Hambletonian	1871 to 1874	9	2.21½	32,500
Jenny	b m	Red Eagle	1873 to ——	13	2.22½	24,900

NAME.	Des.	Sire.	Career.	Won.	Record.	Amount.
Jersey Boy	b g	Young Volunteer	1873 to 1881	36	2.21¼	$12,325
J.J Bradley (Lookout and J. Nesbit)	b g	Unknown	1867 to 1872	15	2.25½	12,585
Joe Brown	wh s	Woodward's Rattler	1870 to 1877	33	2.22	25,700
Joe Ripley	b g	Swain's Hambletonian	1874 to 1880	52	2.25	19,579
John H	b g	Blumberg's Bashaw	1872 to 1882	23	2.20	21,550
John Stewart	b g	Tom Wonder	1867 to 1878	10	2.30	17,600
Joker	b g	Parrish's Hambletonian	1872 to 1877	17	2.22¼	18,000
Judge Fullerton (Bull colt)	ch g	Edward Everett	1870 to 1878	32	2.18	102,035
Kansas Chief	b g	Young Josephus	1870 to 1878	22	2.21¼	39,800
Kilburn Jim	b s	Wood's Hambletonian	1871 to 1872	10	2.23	17,450
Lady Emma	ch m	Jupiter	1862 to 1866	6	2.26½	11,000
Lady Foxie	ch m	Daniel Lambert	1873 to 1880	20	2.24¼	10,400
Lady Franklin	rn m	Vermont Black Hawk	1854 to 1865	11	2.31	12,130
Lady Maud	b m	General Knox	1872 to 1880	8	2.18¼	22,200
Lady Moscow	b m	Unknown	1846 to 1856	28	2.30	11,400
Lady Snell (Belle of Vermont)	b m	Godfrey's Patchen	1872 to 1878	9	2.23¼	11,740
Lady Star (Capitola)	b m	Sir Henry	1870 to 1881	39	2.24	15,850
Lady Suffolk	gr m	Young Engineer	1838 to 1852	75	2.26½	29,750
Lady Thorn	b m	Mambrino Chief	1863 to 1870	41	2.18½	79,575
Lady Vernon	gr m	Unknown	1852 to 1855	13	2.29½	11,200
Lancet	blk g	Vermont Black Hawk	1856 to 1863	14	2.27½	14,850
Lantern	b g	Black Bashaw	1855 to 1858	5	2.32½	25,000
Latham	b s	Alexander's Abdallah	1866 to 1874	8	2.33¼	12,635
Lewinski	b g	Mambrino Messenger	1874 to 1879	14	2.25¼	11,450
Lew Scott	b g	Scott's Hiatoga	1875 to 1880	31	2.23	26,150
License	ch g	Unknown	1866 to 1870	11	2.26½	16,200
Little Fred	b g	Eastman's Morgan	1874 to 1878	18	2.20	29,250
Little Gipsy (Lady Price)	b m	Tom Hal	1875 to 1882	23	2.22	13,520
Loafer	rn g	Copperbottom Horse	1874 to 1882	31	2.24½	18,425
Logan	ch s	Wadleigh's Logan	1868 to 1874	24	2.28	18,270
Lucille Golddust	b m	Golddust	1871 to 1877	16	2.16¼	43,000
Lucy	b m	George M. Patchen	1865 to 1873	23	2.18¼	50,950
Lula (Jenny Perry)	b m	Alexander's Norman	1873 to 1878	18	2.15	32,750
Lysander Boy	ch g	Lysander	1875 to 1878	19	2.20¾	15,500
Mac	br g	Morgan Cæsar	1848 to 1854	18	2.28	14,450
Major Allen (Locust)	ch g	Frank Allen	1869 to 1876	9	2.24¼	15,900
Mambrino Gift	ch s	Mambrino Pilot	1873 to 1874	11	2.20	15,775
Matthew Smith	b g	Unknown	1869 to 1873	13	2.26½	15,350
Maud S	ch m	Harold	1880 to 1881	16	2.10¼	31,500
May Bird	blk m	George Wilkes	1874 to 1877	27	2.21	24,700
May Howard	gr m	Paddy Magee	1871 to 1877	17	2.24	19,200
May Queen (Nashville Girl)	b m	Alexander's Norman	1874 to 1876	7	2.20	21,500
Mazo-Manie	ch g	Kurtz Horse	1875 to 1882	19	2.20¼	19,210
Midnight	blk g	Peacemaker	1878 to 1881	12	2.18¼	11,800
Molly Morris (Kitty Fisk)	ch m	French Pacing Pony	1870 to 1876	32	2.22	30,250
Molsey	b m	Whiteside's Black Hawk	1873 to 1875	12	2.21½	15,250
Monarch, Jr.	rn s	Strawn's Monarch	1874 to 1878	12	2.24½	13,800
Monroe Chief	br s	Jim Monroe	1875 to 1882	26	2.18½	27,700
Moose	b g	Washburn Horse	1876 to 1881	19	2.19½	12,575
Mountain Boy	b g	Edward Everett	1867 to 1871	9	2.20¾	15,750
Mountain Maid	b m	Morrill	1865 to 1869	23	2.26¾	17,650
Mountain Quail	b m	Widgeon	1876 to 1879	23	2.25½	11,190
Music	ch m	Middletown	1871 to 1875	11	2.21½	14,475
Myron Perry	b g	Young Columbus	1868 to 1871	13	2.24½	14,100
Nelly Irwin	b m	Middletown	1874 to 1882	36	2.25	18,700
Nelly Walton	b m	Jules Jurgensen	1873 to 1875	12	2.26½	14,300
Netty	b m	Rysdyk's Hambletonian	1873 to 1878	14	2.18	46,550
New York	b g	Unknown	1854 to 1858	9	2.32½	12,350
Nonesuch	ch m	Daniel Lambert	1869 to 1873	11	2.25½	14,900
Nutwood	ch s	Belmont	1876 to 1879	15	2.18¾	11,900
Observer	ch g	Revenge	1873 to 1875	15	2.24¼	14,975
Occident	b g	Doc	1873 to 1878	5	2.16¾	13,000
Ohio Boy (Henry Chase)	b g	Unknown	1871 to 1874	22	2.27	14,700
Onawa	blk s	Goodwin's Hambletonian	1878 to 1882	31	2.23½	11,755
Orient	b g	Smith's Mambrino Patchen	1874 to 1876	9	2.24	12,025
Overman	ch g	Elmo	1878 to 1882	11	2.20¼	14,520
Parana	b m	Mambrino Hambletonian	1877 to 1882	12	2.19¼	13,000
Piedmont	ch s	Almont	1875 to 1881	15	2.17¾	23,450
Pilot Temple	b s	Pilot, Jr.	1865 to 1876	34	2.24½	32,135
Powers	b g	Volunteer	1877 to 1878	16	2.21	13,450
Prince	ch g	Jupiter Abdallah	1869 to 1870	7	2.27	10,700
Princess	b m	Andrus' Hambletonian	1858 to 1859	5	2.30	49,500
Prospero	blk g	Messenger Duroc	1872 to 1877	4	2.20	14,950
Proteine	br m	Blackwood	1877 to 1879	18	2.18	18,650
Rarus	b g	Conkling's Abdallah	1874 to 1879	63	2.13¼	114,950
Red Cloud	b g	Legal Tender	1871 to 1876	27	2.18	38,650
Richard	ch g	Blue Bull	1875 to 1880	10	2.21	17,450
Ripton	br g	Unknown	1841 to 1847	18	2.33½	17,150
Robert McGregor	ch s	Major Edsall	1874 to 1881	13	2.18	10,775
Rosa Wilkes	b m	George Wilkes	1880 to 1882	21	2.18¼	18,100
Royal John	gr g	Woodstock	1869 to 1876	9	2.26¼	10,875
Sam Purdy	b s	George M. Patchen, Jr.	1873 to 1876	13	2.20½	33,500
Santa Claus	b s	Strathmore	1879 to 1882	14	2.17½	32,050
Sciola (Kate Wesner)	b m	Hanshaw Horse	1877 to 1882	26	2.23¼	11,440
Scotland	blk g	Bonnie Scotland	1875 to 1879	13	2.22½	12,450
Sea Foam	gr m	Young Columbus	1871 to 1875	8	2.24½	11,450
Sensation	b m	Dixon's Ethan Allen	1872 to 1875	13	2.23½	53,500
Shepherd Knapp, Jr	b g	Shepherd F. Knapp	1860 to 1875	19	2.28¼	12,950
Silas Pich	ch g	Young Priam	1868 to 1874	28	2.24¾	17,175
Silvers' Ies	gr g	Unknown	1871 to 1879	30	2.22	13,355
Silverton	b g	Blue Bull	1879 to 1881	12	2.30¼	10,300
Sleepy John	b g	Unknown	1867 to 1872	18	2.25	23,600
Slow Go	rn g	Young Sharatack	1873 to 1877	19	2.18½	26,000
Smuggler	b s	Blanco	1874 to 1877	13	2.15¼	36,500
Snowball	gr g	Unknown	1869 to 1877	20	2.27½	11,225
Spotted Colt	sp g	Unknown	1870 to 1876	27	2.25½	12,600
Steve Maxwell	gr g	Ole Bull, Jr.	1875 to 1881	15	2.21½	12,900
Stewart Maloney	b g	Charles E. Loew	1871 to 1882	10	2.27	14,550
St. James (Bay Billy)	b g	Gooding's Champion	1872 to 1877	27	2.23¼	42,815
St. Julien	b g	Volunteer	1875 to 1881	24	2.11¾	60,600
Susie	ch m	Hampshire Boy	1871 to 1876	20	2.21	36,350
Tacony	rn g	Sportsman	1851 to 1859	22	2.27	18,000
Tanner Boy	gr g	Edward Everett	1873 to 1877	25	2.22½	17,050
Thomas Jefferson	blk s	Toronto Chief	1869 to 1878	27	2.23	43,600
Thornedale	b s	Alexander's Abdallah	1876 to 1877	5	2.22¼	11,600
Tom Keeler (Cayuga Chief)	b g	Jersey Star	1867 to 1882	37	2.25	25,350
Trinket	b m	Princeps	1879 to 1881	20	2.14	27,600
Unolala	b m	Volunteer	1880 to 1882	20	2.22¼	19,800
Voltaire	br s	Tattler	1877 to 1881	14	2.20¼	13,250
Wedgewood	br s	Belmont	1877 to 1881	18	2.19	23,100
White Stockings	b g	Unknown	1874 to 1877	14	2.21	10,850
Will Cody	b g	Blue Bull	1879 to 1882	20	2.19½	14,600
William H	b g	Young Wilkes	1879 to 1881	29	2.18½	18,030
William H Allen	b s	Volunteer	1871 to 1876	15	2.23½	12,190
Wolford Z	b g	Captain Beaumont	1874 to 1878	16	2.22	10,900
Young Bruno	br g	Rysdyk's Hambletonian	1871 to 1874	10	2.22¾	16,150

THE average birth rate per annum in France for the period between 1872 and 1880 has been calculated to be one birth for 37 inhabitants; Russia, one birth for 20 inhabitants; Germany, one birth for 25; Austro-Hungary, one birth for 26; England, one birth for 27; Italy, one birth for 27; Spain, one birth for 28; France, one birth for 37. If the yearly number of births for any thousand inhabitants be calculated, we have precisely the same result. We have in France, 26 births per 1,000; Belgium, 32; England, 35; Austria, 38; Prussia, 38; and Russia, 38.

THE DEVIL'S PIT.

By Rev. JOHN D. PARKER, U. S. A.

IN Crockett County, Texas, on the divide between Devil's River and the Nueces, there is a cavern in the rocks that has been named the Devil's Pit. The divide at this point is perhaps a thousand feet above the level of the river. The cavern in the ground is about eighteen feet across at the top, and has the form of an inverted perpendicular cone, being several hundred feet across at the bottom. Perhaps a hundred men have gone to the cavern with the purpose of being let down into it, but concluded when they saw it that some one else might have the glory of exploring it. Recently a man was found who had the nerve to see if the cavern was rightly named. As he passed down by a rope held firmly above, he found the bees had made their hives in the sides of the rock. He declared there were tons of honey in the cavern. If the air had not been rather cold, he could not have gone down without being stung. About ninety feet down he found a small live oak tree growing on the side of the cavern, the roots fast in the rocks.

When he had been let down one hundred and eighty feet, he came to the top of a mountain of rock in the shape of a solid cone—a cone within a hollow inverted cone—with plenty of room between them to explore the cavern. So he let go of the rope and went down the sides of this mountain about a hundred feet, when he came to a lake of water. This water appeared to be deep, but he had no means of measuring its depth. A canteen was let down to him, which he filled and brought up. The water was clear and agreeable to the taste. On the outside down the hill the water sweeps out of the rocks, and people now think it is the outlet of the lake in the cavern. Whether the water has gathered in the cave from the orifice at the top, or a stream flows under ground, it is impossible to determine with the present limited observations.

This cavern is situated about ten miles east from Judge M. D. Kent's sheep ranch, and about forty miles northeast of Fort Clark. This is a very wild region, with few inhabitants. Recently a panther was killed in this vicinity which measured from tip to tip thirteen feet. This is the sixth panther that has been killed in this vicinity within a few months. The Mexican lion, or cougar, is also found in this region, and in the jungles of the Rio Grande is found the leopard cat.

It has not been determined whether the cavern is the result of erosion from running water, or was formed by volcanic action. Nothing can be known about it scientifically without an examination by a competent geologist. Texas is full of interest to the scientist, but almost nothing has been done in this direction. There are probably rich mines of coal, silver, lead, and tin, and perhaps other metals. The State has a full treasury, and all it needs is a wise direction given to produce results which would return many times their cost. The flora and fauna are especially rich. Taxidermists are frequently sent here to enrich the collections of Eastern institutions.—*Kansas City Review.*

BRITISH COLUMBIA—ITS CLIMATE, RESOURCES, AND PEOPLE.

AT a recent meeting of the Balloon Society of Great Britain, a paper was read by Mr. P. O'Leary, on his travels in British Columbia. He said that geographically and climatically, British Columbia might be divided into two distinct parts: the fine island of Vancouver, and a large number of smaller islands in the Gulf of Georgia making one geographical portion, while the whole of the mainland of British America west of the great chain of the Rockies would be the other, the political union of the two forming the magnificent country known as British Columbia.

On the southeast coast of Vancouver is the pretty city of Victoria, the seat of Government and largest town in the province, the population being about 7,000. The scenery was simply grand. The Olympian Mountains and the mainland of Washington territory, with their tops in eternal snow, and their base washed by the lake-like waters of Puget Sound. West of them, in British Columbia, where the still grander range of the cascade mountains, their sides and slopes for hundreds of miles covered with the finest pine timber in the world, which for commercial purposes is as yet, comparatively, undeveloped. The view from Victoria across the Sound to those lofty mountains, which in reality are a continuation of the great chain of the Sierras of California and Nevada, is very beautiful. Esquimault, three miles from Victoria, is one of the loveliest harbors on the Pacific Coast, and the Station of the British Squadron in those waters. The eastern side of the island was tolerably well settled, there being several villages scattered along the coast, and on the north-west front of the island on a splendid sheet of water, was the important mining town of Nanimo. At this place there were three or four large coal mines, from which the British Navy, and all other steamships in the North Pacific were coaled. Nanimo he might describe as a Welsh or Cornish mining village, with a few Indians and Chinese thrown in, as the place was principally made up of people from the mining districts of England. There were other minerals on the island, but coal was the most extensively worked. Many, however, of the smaller islands in the Gulf of Georgia, and of the Archipelago, known as the Queen Charlotte Group, were simply huge rocks of various minerals: for instance, Texeda Island was one great ironstone, while a few miles away was San Juan Island, made up of limestone. The possession of this mass of limestone was a few years ago in dispute between the United States and Great Britain, and both countries consented to leave the matter to the arbitration of the King of Prussia, now Emperor of Germany, and he awarded it to the Americans, account of its adjacency to their territory. Here was coal at Nanimo in abundance, ironstone on Texeda Island, close at hand, and lime for flux on San Juan. The finest timber in the world on the mainland outside the cascades, and splendid waterway in every direction, to which might be added a genial climate; and with such natural advantages, what was there to prevent British Columbia becoming one of the great manufacturing centers of the Pacific Coast. He would predict that when the Canadian Pacific Railway was completed—and as a result more population, capital, and enterprise carried into the province—British Columbia would be the South Wales of the Western portion of the New World.

Passing on to the mainland, the lecturer gave a vivid description of the Cascade Mountains, which were as yet comparatively unexplored. The range was about one hundred miles wide, and nearly all more or less covered with timber, principally the Douglas pine, which on their sea-front grew to an enormous size. The Frazier River was the great drain of the Pacific side of the Dominion, as the St. Lawrence

was on that of the Atlantic. Although the Frazier was a fine, picturesque river, it was not navigable for large vessels, but nine miles, however, west of its mouth was Port Moody, a really splendid harbor and the terminus of the Canadian Pacific Railway. At the mouth of the Frazier was the pretty town of New Westminster, on one side of which there was a large fertile delta, that by a little enterprise might be reclaimed from the occasional tides which now cover it. As the province had self-government, and the people nerve and energy, the reclamation of this fine fertile delta will doubtless be soon carried out. In the opening made by the Frazier through the Cascades, there is a current of warm air from the Pacific that tempers the colder climate of the interior, which increases in severity from the inside of the mountains to the headwaters of the Frazier on the western foothills of the Rockies. Nowhere, however, is the climate very severe, and all over the inland plain of British Columbia cattle remain out more or less throughout the winter. A vast area of the land is fit for agriculture, but at present a deal of it is used for grazing purposes. Minerals are found nearly everywhere: gold, silver, copper, iron and coal being as yet the most abundantly discovered. For some years the gold yield, in proportion to the capital invested and labor expended, was the most remunerative of any yet discovered, the work being carried on by what is called placer mining and rock-washing, there being little or no crushing or deep mining, as on the Comstock, in Nevada. Gold miners he found to be a very intelligent order of men, most of them being tolerably well educated, which may be accounted for from the fact that a spirit of enterprise and adventure caused many of them when young to leave good homes. Nowhere in the world is law and order better maintained than in British Columbia, the strong arm of legal justice reaching every member of the community, rich and poor alike. The white, or ruling population, was made up of English, Irish, Scotch, and Canadians, with a sprinkling of Americans, who at present carry on a deal of the trade of the province. There were some Chinese engaged in small industries and domestic service, but they did not come much into conflict with white labor, as there was at present plenty of room for all, although in a certain sense they were an injury, while in another a benefit. There were no hostile Indians, most of them being semi-civilized, while those who were not never committed any serious depredations. The Catholics, the Church of England and Methodist communions had missionaries among the Indians, but they had a difficulty to grasp the higher principles of Christianity; and even among those who bowed to the missionary, the native medicine-man still wielded great influence."

SULPHUR IN ITALY.

SULPHUR is the most important of all the mineral products of Italy. Its annual production is greater in value than that of all the other mining industries put together, and more workmen find employment in this than in any other branch of industry on the peninsula.

Sicily, which is the leading sulphur district, has about 275 sulphur mines, which produce 86 per cent. of all the sulphur obtained. In the Romagna, *i. e.*, near Ancona, Rimini, and Cesena, there are abou. twenty works that produce 11 per cent., the remaining 3 per cent. being obtained from four or five works near Naples, and in the (former) States of the Church.

In most cases the sulphur is found in a limestone or calcareous marl; sometimes, too, in gypsum, in which the amorphous metalloid occurs in such a very fine state of division that it cannot be detected or recognized with the naked eye; but sometimes the pieces are as large as peas and hazelnuts, or it forms fine threads through the rock.

The sulphur-bearing stratum is the Miocene, which is very prominent in the peninsula, and can be traced with considerable regularity from the northeastern declivity of the Apennines southward until it leaves the peninsula in the province of Avellino and reappears in Sicily. The lower part of this formation consists chiefly of a silicious limestone, while the upper consists of alternate layers of gypsum and marl. These serve as guides to the miner, and from their appearance he can predict with tolerable certainty whether the layer beneath will be sulphur-bearing or sterile. If the former, grains of sulphur will be found sprinkled through the gypsum. The thickness of the stratum that holds the sulphur, as well as its richness in this material, vary within very wide limits. The position of the Miocene is extremely regular; faults are very rare, and offer no difficulty to the miners. In addition to these sedimentary beds of the Tertiary, sulphur minerals worth mining are found in the extinct and half extinct volcanoes of the Viterbo, the Lipari Isles, and in the region around Naples. But in these places the mining operations are never carried out on a large scale. From the crater of the Volcano Isle about 150 tons are now obtained annually.

The sulphur is brought out of the mines usually by the most primitive methods imaginable, being carried in sacks and baskets on the shoulders of young, boyish miners through galleries that frequently have an inclination of 30° to the horizon until they reach the light of day. The number of these workmen, called *carusi*, may be estimated at 3,500 or 4,000. Steam hoists are met with only at the largest works in the island. In Romagna, where the formation is not so favorable (the depth of the mines averaging 670 feet, as compared with 500 feet in Sicily), they are a little further advanced. Steam lifts are employed at all the deeper shafts, and at the shorter ones the hand windlass is used; and only in very rare cases is it borne on the shoulders. Now and then horse power is used in raising the ore. Mine railways were almost unknown a few years ago, but are gradually coming into use, the improvement in the sulphur market in the last few years having had the effect of livening up the sulphur industry.

The arrangements for getting rid of the surface water, which is noticeable in Sicily, where the average depth of the mines is yearly increasing, are still less in accord with the times. Steam pumps are a rarity; pumps for horse or hand-power are usually insufficient, and drainage canals are infrequent, owing to the conformation of the ground, or can only be made at great expense. A whole row of Sicilian mines are at this time full of water, and hence cannot be worked.

Ores containing 10 to 25 per cent. of sulphur are mostly worked in the old way by smelting in *calcarone*. These usually consist of a cylinder about 33 feet in diameter and 7 to 10 feet high, made of masonry, with the floor inclined to one side to allow the sulphur to flow out. The mineral is piled up in it and set on fire, and then left to itself. Owing to the moisture in the ore, it heats very slowly, and the sulphur does not begin to run out from the channel at the bottom into the moulds for five or six days after it is set on fire. It takes about a month to burn a charge of 130 to 150 tons.

It is easy to see that in this crude operation a large quantity of sulphur is lost, for it is impossible to regulate the draught so that only enough sulphur will be burned to melt out the rest. The average yield of this process is 57 per cent.; the rest of the sulphur, 43 per cent., is burned. Earthy and porous masses are hard to melt in calcarone, as the former sinter together, and the latter expose too large a surface. Hence it is impossible to smelt the porous sulphur-bearing lavas from recent volcanic eruptions alone, as the sulphur would all burn up unless mixed with poorer but more compact masses. Theoretically, many objections can be urged against the calcaroni; but in practice it must be admitted that, for most ores, it is the most profitable. This is evident (?) from the fact that 93 per cent. of all the sulphur produced in Italy is made in calcarone. Of the total 300 sulphur mines, only two work exclusively with other systems; the rest keep their calcarone, even if they do occasionally use other processes for treating special ores.

Although in recent times a great many propositions and experiments have been made for the purpose of finding a method of recovering the sulphur, which should fill all the requirements of the industry, none have as yet been successful.

The difficulty consists, in the first place, in the scarcity of cheap fuel; in the second, in the differences in the ore to be worked. A large number of the plans proposed are useless, owing to the cost of the apparatus. Not a year has passed within the last decade but what two or three new systems have been tried, but in most cases the results were unsatisfactory. It would take too long to enter into a description of all the processes that have been tried and abandoned; a short sketch of those still in use will be of more interest.

The next oldest process after the calcaron is that called *doppion*. Here the sulphur ores are roasted in cast iron vessels with ordinary fuel, the air being excluded so that the sulphur either melts and runs out, or, more frequently, is distilled off. In the latter case, a pure product is obtained at once, requiring no refining. The vessels are of different shapes, mostly those of crucibles or bottles, and may hold as much as half a ton of ore. This is the process generally employed in the Romagna works. The sulphur yield averages about 84 or 85 per cent. of the total amount; the cost of running it is considerably higher than with calcarone, and hence it is only used for especially rich ores, or such as are of such a nature that they cannot be worked in the calcarone. Several improvements in doppions have been proposed. For sake of ease in charging and emptying them, and to make them nearly continuous in their working, Zenone introduced horizontal retorts like those used for making gas or coal tar. For similar reasons, Sinopoli and Maltura smelt the ores in vertical cylinders of boiler iron. In spite of numerous attempts at improvement, neither system has yielded really satisfactory results.

At several of the large works in Sicily superheated steam is employed. This is Thomas' method, but is known there as the "Milan System," for it was first introduced by a company from Milan. At all events it is the most rational of all that have been mentioned, as the loss of heat can be reduced to a minimum. Sulphur melts at 114° C. (237° Fahr.), so that steam at 135° or 130° C. (257° to 266° Fahr.) will accomplish the fusion in a short time. This process is said to give good results with rich or medium ores, but not with poor ores, which is the chief reason why it is not more extensively employed. It is probable, however, that the real objection is the cost of the plant, for poorer ores give comparatively worse results in any other system, for the quantity of heat required in melting it out, independently of the latent heat of the sulphur, is the same for the same amount of ore, whether this is rich or poor. The total quantity of material must be heated to about 125° C., but in all other systems this temperature is exceeded, and poor ores should give still less satisfactory results by them than by Thomas' process.—*Chemiker Zeitung.*

TELLURIUM IN COPPER.

By T. EGLESTON, Ph.D., New York City.*

SOME months ago, samples of black oxide of copper and of pig-copper from Colorado were sent to me to examine for arsenic and antimony. I examined them both by the blowpipe and in the wet way, but found none present. A quantity of this material was purchased by a large metallurgical works; but when they attempted to refine it, they pronounced it to be full of arsenic and antimony; so much so, that their furnaces were, as they said, "poisoned," and rendered unfit for refining. I then re-examined the samples, and at the same time some of the material which had "poisoned" the furnaces, and found no traces of arsenic or antimony when the usual amounts for analysis were used; but on taking very large amounts I found traces merely, in some parts of the sample, but not in all. As it was a matter of interest to ascertain what the white substance that "poisoned" the furnace was, I sent to the works making the black copper, and obtained some of the matte from which the black copper was made. I took careful samples of it and the black copper and the refined copper. I then found the impurity to be tellurium, a substance heretofore known as occurring in copper. I give below an analysis of the matte, two of the black, and one of the refined copper:

	Matte.	Black copper.		Refined copper.
Copper	55·02	97·120	98·090	99·705
Gold	0·06	—	—	—
Silver	0·40	0·132	0·128	0·135
Lead	17·87	0·777	0·757	none
Zinc and nickel	2·22	0·070	0·100	0·024
Iron	4·18	0·130	0·080	0·031
Sulphur	20·02	0·236	†	trace
Tellurium	0·12	0·093	0·097	0·083
Arsenic	†	0·006	†	0·091
Slag, etc	—	1·270	0.192	—
	99·89	99·834	99·444	100·069

The mattes and the black copper are results of the treatment of copper ores with the tellurium ores of Colorado. In the laboratory, no traces of white fumes were shown on charcoal; but when the metal in the furnace was subjected to the process of "dry roasting," as was unintentionally done, very dense white fumes were given off. When refined and cast into cake, it had the ordinary appearance of cake copper. It was then reheated for rolling in the ordinary way, showing no signs of impurity. At the first pass in the rolls, very fine cracks showed themselves, which opened in succeeding passes. At a thickness of about 0·03 meter, the cracks on each side nearly penetrated the cake, and at about 0·008 meter it began to fall to pieces. It was heated and rolled at different temperatures, but always with the same result. When cold, the metal is tough and malleable. Although the cakes in the moulds showed no coating, when they were heated repeatedly and allowed to cool in the air they became covered with a white powder, which proved to be the oxide of tellurium. The copper, as it comes from the cake-moulds, has every appearance of being good copper.

This is the first time, so far as I know, that the presence of tellurium has been detected in commercial copper. But very little of it is removed in the treatment, as the four analyses show. It is surprising how very small a quantity renders the copper red-short, and consequently worthless for rolling.

* A paper read at the Harrisburg meeting of the American Institute of Mining Engineers.

† No traces were found with the blowpipe.

NUTRITIVE VALUE OF SKIM MILK.

By J. KONIG.

COMPARING skim milk (N.R. 1:2) with whole milk (N.R. 1:3·5), the author shows that skim milk is by far the cheapest and most nutritious food for adults; also it is shown that the price paid for the albuminoids in skim milk is lower than that paid for them in any of the ordinary foods which appear in the markets, excepting stockfish; as, for example, 1,000 nutritive units in skim milk cost 41·7 pfennings, while in pork they cost 71·4; in butter, 81·7; and in eggs, 201·2. Stohmann has calculated that 1 liter skim milk corresponds in nutritive value to 160 grammes boneless meat, the latter costing 19·2 pfennings, while the former costs only 8·10.—*Bied. Centr.*

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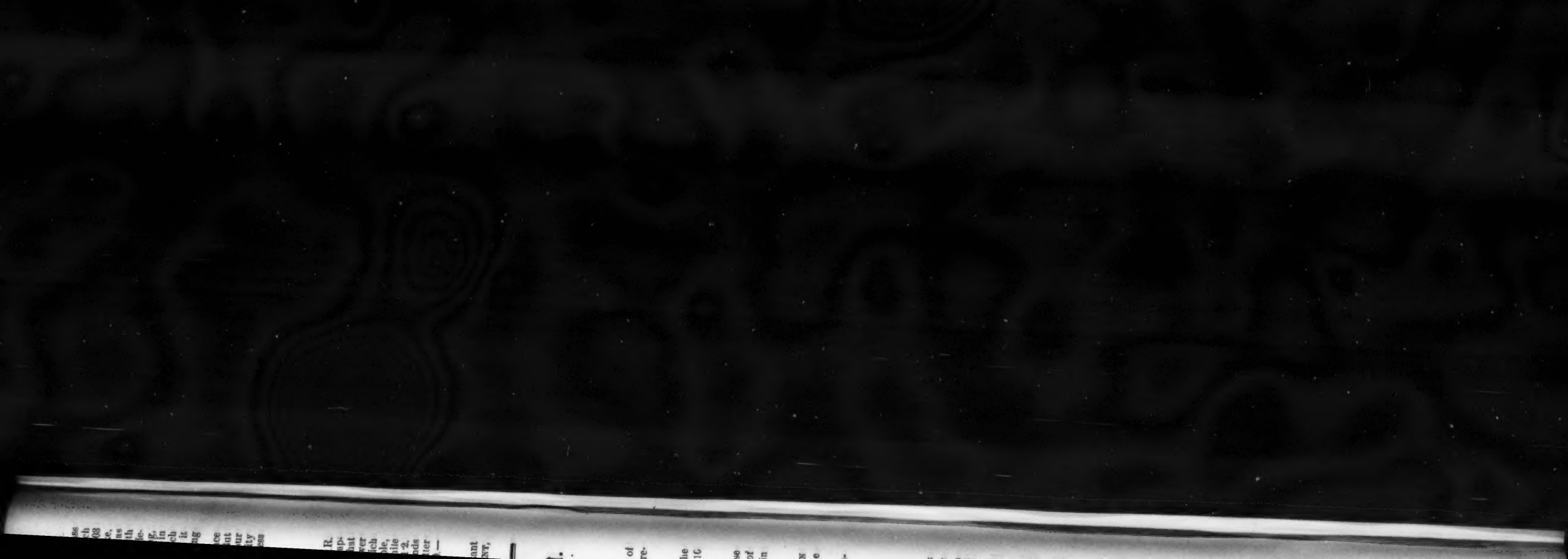
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